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Flying Operations

T-38C FLYING FUNDAMENTALS

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This manual implements AFPD 11-2, *Aircraft Operations,* and AFI 11-2T-38, Volume 3, *T-38 Operations Procedures*. It provides a comprehensive document containing T-38 fundamental procedures and techniques that may be used to accomplish the various missions of the T-38 in any major command (MAJCOM). This publication is the primary T-38 mission employment reference document for Air Education and Training Command (AETC). Maneuvers and procedures not described in this publication will not be accomplished without specific prior approval from the AETC Deputy Director of Intelligence, Operations, and Nuclear Integration (HQ AETC/A2/3/10-FT). With the exception of associate instructor pilot (IP) programs, this publication does not apply to the Air Force Reserve Command or the Air National Guard.

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Chapter 1

MISSION PREPARATION

1.1. Overview . The objectives of every sortie in undergraduate flying training (UFT) are to achieve proficiency in flying maneuvers, maximize situational awareness, increase decision making skills, and successfully apply task management skills. Preparation for any training mission should be based on these objectives. The overall mission objective should give the "big picture" of what needs to happen to accomplish a successful sortie. More specific objectives should be used to determine success in relation to the syllabus, course training standards, continuation training requirements, etc. A valid objective is realistic, achievable, and measurable.

1.2. Mission Briefing and Debriefing.

1.2.1. General Rules of Engagement (ROE). During briefings and debriefings, the briefer is in charge and should be the only one speaking until he or she asks for inputs. Any questions or comments should be saved until requested by the briefer. Generally, no food or drink is allowed during briefings without the approval of the briefer.

1.2.2. Briefing. ***The aircraft commander (AC) or flight lead must ensure the mission is thoroughly briefed. As a minimum, use the briefing guides in appropriate AFI 11-series publications, and include discussions on formal special interest items (SIIs).*** Other members of the flight or formation should be prepared for the brief and assist the AC or flight lead as directed. The brief should focus on successfully accomplishing all the objectives.

1.2.2.1. Standard Mission Elements. Mission elements may be briefed as "standard" provided they are published, and the proficiency level of all flight members would allow them to be briefed as such.

1.2.2.2. Expectations. On student training sorties, the student is expected to obtain relevant notices to airmen (NOTAMs), weather, airfield status, threat of the day, emergency procedure of the day, etc., and have a lineup card prepared. On nonstudent training sorties, the briefer will assign these responsibilities. Before the brief, all crewmembers should ensure all go/no-go items are accomplished and life support equipment is available and inspected for flight.

1.2.3. Debriefing**.** The main goal of the debrief is to determine if mission objectives were achieved and to what level. Before the debrief, the student (or designated crew member) should post the objectives and cue the tape to the G-exercise (or as directed by the debriefer). If T-38 Mission Debrief System is used, it should be loaded and prepared as directed by the debriefer.

1.2.3.1. The debriefer should curtail time spent on administrative items based on the experience or proficiency level of the flight members, and avoid an item-by-item description of every event that occurred. Instead, the debriefer should cover what went right and what went wrong, with emphasis on the root cause of relevant errors and how to improve on subsequent missions. The debriefer should relate everything back to the mission objectives.

1.2.3.2. For student sorties, the instructor pilot (IP) will identify areas of emphasis for the next sortie, and provide focused instruction on them in this sortie's debrief. The IP should summarize at the end with emphasis on the major learning points and considerations for future missions.

1.2.4. Formation Debrief. The flight lead should focus on formation-specific items, leaving single-ship execution for individual aircraft debriefs. The amount of debrief allotted to the entire flight is also affected by the skill level of the flight members, the presence of solos in the flight, and the potential benefit to the entire flight of the items being discussed.

Chapter 2

GROUND OPERATIONS

2.1. Objectives. The objectives of ground operations are to safely and correctly prepare the aircraft for flight and return the aircraft to parking after flight.

2.2. Checklist Discipline. ***Ensure completion of all items in accordance with (IAW) the applicable flight crew checklist.*** However, aircrew need not reference the checklist to complete each individual item. You may accomplish a few items and then refer to the checklist to ensure completion of all items. The pilot at the controls should initiate all checks and ensure the asterisked items are accomplished. ***Challenge and response will be used to accomplish asterisked items during student training***.

2.3. AFTO Form 781, *ARMS Aircrew/Mission Flight Data Document*, Review and Walk Around. ***Ensure the AFTO IMTs 781 are complete, correct, and the aircraft is airworthy. Perform a walk around IAW the flight crew checklist.*** If any doubt exists as to the condition, setting, or operation of any system, consult a qualified maintenance representative.

2.4. Ground Visual Signals. Keep hands clear any time someone is under the aircraft. The crew chief is your safety observer. Monitor the crew chief's signals closely for safety actions. All visual signals will be IAW AFI 11-218, *Aircraft Operation and Movement on the Ground*.

2.5. Foreign Object Damage (FOD) Avoidance. To reduce the risk of FOD during ground operations, ***do not place objects on the cockpit glareshields during engine start or while the engines are running unless the canopies are down and locked***. In addition, do not allow personnel to climb on the aircraft with either engine operating, and do not hand objects over the cockpit side unless the engine on that side is shut down and has stopped rotating. Loose items in the cockpit also pose a hazard to the multi- function display (MFD), up front control panel (UFCP), and electronic engine display (EED) glass. Crews must exercise caution to ensure items, especially the helmet and oxygen hose, do not strike these components.

2.6. Taxi Operations.

2.6.1. Clear in all directions before advancing the throttles. Keep the use of power to a minimum. Normally, a power setting less than 80 percent revolutions per minute (rpm) should be enough to taxi. ***Check the nosewheel steering and brakes as you taxi out of the parking spot.***

2.6.2. ***In congested areas, reduce throttles to idle while turning to avoid jet blast damage*** to ground equipment, aircraft, and personnel. ***Check the flight instruments in the turn onto the taxiway or ramp, not the marshaling turn out of the chocks.*** Aircrews should taxi at a moderate speed, normally not greater than 25 knots groundspeed (GS) (available on the MFD while taxiing). As a technique, taxi no faster than the reported runway condition reading (RCR). Stagger only in authorized areas. Slow down and taxi on the centerline in congested areas.

2.6.3. Use the brakes sparingly to prevent wear and overheating. When using the brakes, ensure the throttles are in idle. Adjust taxi speeds during high or gusty wind conditions to prevent exceeding the 30-knot relative wind canopy limit. When opening the canopy in high or gusty winds, hold the canopy frame to prevent rapid fly-up.

2.6.4. When taxiing closely behind aircraft with engines running, lower the canopies to prevent exhaust windblast effects. ***Do not taxi within 10 feet of any obstacle. Do not taxi within 25 feet of an obstacle without a wing walker***. ***For additional procedural guidance, refer to AFI 11-218, AFI 11-2T-38, Volume 3, and the flight manual.***

2.7. Instrument Cockpit Checks. ***Before flight, accomplish a thorough instrument cockpit check according to AFMAN 11-217, Volume 1, Instrument Flight Procedures*****.** Checking the following items will satisfy all requirements:

2.7.1. **Navigation Publications.** ***Ensure all publications required for your departure, enroute, destination and alternate are current***.

2.7.2. Pitot Heat. Check for proper operation, including the heating of the total air temperature probe and angle of attack (AOA) transducer vane**.**

2.7.3. Clock. Check for correct time of day.

2.7.4. Vertical Velocity**.** All should indicate zero.

2.7.5. Attitude System. ***Set the standby attitude indicator at 3 degrees nose-low.*** The EADI should indicate 3 degrees nose low if the aircraft is on level ground. If the climb/dive marker (CDM) is selected, the horizon line is displayed in the center of the EADI coincident with the waterline symbol when the aircraft is on level ground.

2.7.6. Heading System**.** ***Ensure the electronic horizontal situation indicator (EHSI) is within 8 degrees of the magnetic compass and within 5 degrees of a known heading.*** Check for correct indicator movement in turns.

2.7.7. Airspeed Indicators. ***Check for proper indications on the HUD, MFD, and standby indicators.***

2.7.8. Altimeters. The maximum error of each altimeter at a known elevation point is 75 feet.

2.7.9. Embedded GPS/Inertial Navigation System (INS) (EGI) Area Navigation (RNAV) Check. ***Prior to conducting RNAV operations, verify the currency of the International Civil Aviation Organization (ICAO) database, the aircraft's present position (PP) during alignment, the GPS is providing civil (C) code data; blended "EGI" solution, and verify the EGI accuracy.***

2.7.9.1. EGI Accuracy. ***RNAV enroute navigation operations may be conducted with the EGI operating in the INS only solution provided a full gyrocompass alignment has been completed IAW T.O. 1T-38C-1, and the predicted accuracy of the INS is 7 (greater than 500 up to 1,000 meters) or less***.

2.7.10. Flight Director System and Instrument Landing System (ILS) Check:

2.7.10.1. ***Tune and identify an appropriate ILS frequency, set the final approach course, select ILS as PNS.*** Absence of a CDI, a vertical deviation indicator, or pitch and bank steering indicates either a lack of data or a system failure. Glideslope raw data and pitch steering may not be present until proximity to the glideslope transmitter is resolved.

2.7.11. TACAN/VOR/DME Checks: **(Note: CDI displays will be checked with either TACAN or VOR as the PNS.)**

2.7.11.1. TACAN, VOR, and DME Channels. ***Tune and identify appropriate TACAN, VOR, and DME channels.*** Verify the MFD NAV data block displays the correct channels. The NAV data block will indicate the TACAN station identifier, if available. With valid signals, check that the range data block contains valid data and the primary flight reference provides a CDI for both TACAN and VOR as the PNS.

2.7.11.2. Bearing Pointers**.** ***Ensure the bearing pointers point toward the stations.***

2.7.11.3. CDI Requirements. ***Center the CDI and check for proper CDI displacement.*** One technique is to change the course by 5 degrees and verify the CDI deflects one dot.

2.7.11.4. TO-FROM Indicator. ***Check the TO-FROM indicator. Change the selected course past 90 degrees from the centered CDI course and check that the TO-FROM indicator switches sides.***

2.7.11.5. NAVAID Ground Checkpoint Checks. At designated ground check points, the allowable bearing pointer and CDI error is ± 4 degrees from the depicted course to the station. The allowable DME error is ½ nautical miles (NM) or 3 percent of the distance to the facility, whichever is greater. (**Note**: When a designated ground checkpoint is not available, the VOR and TACAN are both considered reliable for instrument flight if the systems check within ± 4 degrees of each other against collocated VOR and TACAN stations.)

2.7.12. Side Slip Symbol. ***Check to ensure that the side slip symbol (trapezoid shape located below the bank arrow on the HUD and the MFD EADI) indicates properly in turns.***

2.8. End of Runway (EOR):

2.8.1. ***Check the FCP speed brake switch to ensure it is centered and up*** .

2.8.2. Review takeoff procedures as well as how you might handle serious emergency procedures during and immediately after takeoff. Review your go/no-go criteria. A common technique is to set the go/no- go speed as the green speed and single-engine takeoff speed (SETOS) as the yellow speed. Another common technique is to set Guard (243.00) in the backup ultra-high frequency (UHF) radio as the UHF backup frequency in case of MDP failure during a time critical emergency.

2.8.3. When inspecting the flight control surfaces during the before-takeoff checks, there are two separate tasks. The first task is to visually confirm free and proper movement of the flight control surfaces. Apply smooth and controlled stick movements while confirming the direction and deflection of each flight control surface. Failure to be smooth and controlled could place undue strain on the aileron control mechanisms. The second task is to check for rudder and aileron neutrality. ***With the stick and rudder pedals in the neutral position, check that all surfaces are approximately flush with the surface of the wing and the vertical stabilizer.*** It is crucial that this final surfaces check occurs as close as possible to takeoff. ***The final check of aileron and rudder neutrality should occur no earlier than arriving at the EOR/hold short area and no later than taking the active runway. Check other aircraft for leaks, loose panels, proper configuration, streamers, FOD, etc. If able,***

make sure their stabilator is properly trimmed for takeoff by inspecting the alignment marks. Alert the aircrew if anything looks abnormal.

2.8.4. Ensure the VDTS card has been titled, as required, and that the appropriate display is being recorded via the VTR key display IAW mission requirements. Title the VDTS to include callsign, tail number, name(s), date, and mission.

2.9. Taking the Active Runway.

2.9.1. Once cleared for takeoff, confirm the approach and departure ends of the runway are clear of aircraft.

2.9.2. Ensure the canopy is down and locked prior to engine run-up.

2.9.3. Note your takeoff time and taxi into a takeoff position that allows maximum use of the runway. ***Release the nosewheel steering button during the last few degrees of turn onto the runway and ensure the nosewheel is centered by allowing the aircraft to roll forward once it is aligned with the runway.*** Momentarily displace the rudder pedals to ensure the nosewheel is disengaged.

2.9.4. Confirm your heading system is within tolerances.

Chapter 3

TAKEOFF, CLIMB, AND LEVEL-OFF

3.1. Introduction. This phase of flight is very dynamic and can be as complicated as any other part of the mission. Complex departure procedures may be required immediately after takeoff in the low altitude environment, and communications can be very busy leaving the terminal area. Emergency situations, when they occur in this phase of flight, require forethought, and quick correct action. Solid preparation is essential to success.

3.2. Takeoff:

3.2.1. Description. Two takeoff options exist: static and rolling. The static takeoff is used early in training because it provides more time to accomplish required checks and verify proper engine operation. A static takeoff is also required at night and for solo students. A rolling takeoff aids traffic flow in a busy pattern and is a smooth transition from taxi to takeoff roll. Rolling takeoffs may increase takeoff distance 150 to 300 feet.

3.2.2. Static Takeoff. ***Disengage the nosewheel steering***. Remind the other crew member to guard the brakes. (When guarding the brakes, do not exert pedal pressure but be in a position to immediately assume control.) Exert as much pedal pressure as necessary to prevent creeping during the engine run-up. Look outside the aircraft and advance the engines to military (MIL) power. Your primary concern is to ensure the aircraft is not creeping forward or pulling to one side. If the brakes fail to hold at MIL power, reduce power and attempt to build sufficient hydraulic pressure by pumping the brakes. If the second attempt to keep the aircraft from rolling fails, consider aborting the aircraft. Once the lineup checks are complete, release the brakes, select maximum power (MAX), confirm afterburner operation, and confirm exhaust gas temperature (EGT) readings stabilize within limits.

3.2.3. Rolling Takeoff. Ensure all lineup checks prior to engine run-up are complete, and taxi onto the runway in a normal manner. After attaining proper runway alignment, check the heading system, ***disengage the nosewheel steering***, and advance the throttles to MAX. Confirm proper engine operation during the takeoff roll.

3.2.4. Takeoff Roll:

3.2.4.1. Maintain directional control by tapping the brakes until the rudder becomes effective. Once the rudder is effective, drop your heels to the floor. This will ensure you do not inadvertently apply the brakes while using the rudder. Check the minimum acceleration check speed (MACS) and remain aware of go/no-go speeds.

3.2.4.2. Depending on aircraft gross weight, pilots should normally initiate backstick pressure at approximately 145 knots calibrated airspeed (KCAS), and set the bore sight cross (F-16 HUD) or waterline (MIL-STD HUD) at 7 degrees nose-high on the pitch ladder (Figure 3.1). Nosewheel liftoff should occur at approximately 155 KCAS, and the aircraft should fly off the runway at approximately 165 KCAS depending on aircraft gross weight. When safely airborne with a positive climb, retract the gear.

Figure 3.1. Takeoff Attitude (Front Cockpit).

3.2.4.3. Following gear retraction, ensure sufficient airspeed exists before retracting flaps, then check gear and flap indications to verify they are up.

3.2.4.4. Whenever significant crosswinds are a factor, use aileron into the wind throughout the takeoff roll to prevent an early liftoff of the upwind wing, and use rudder to maintain runway alignment. As airspeed increases, crosswind control inputs should decrease.

3.3. Climb. Climb IAW local procedures. If practical, use the flight manual performance data Mil Thrust Restricted Climb Schedule or a technique listed below.

3.3.1. In any case, smoothly reduce power out of MAX between 220 and 280 KCAS, and terminate afterburner by 300 KCAS. Accelerate to and hold 300 KCAS using MIL power and approximately 12 degrees pitch until passing 10,000' MSL. Once past 10,000' MSL, accelerate in a shallow climb (approx. 1,000 to 2,000 fpm) to your desired climb indicated Mach number (IMN) based on the climb technique selected. A common airspeed to accelerate to above 10,000’ MSL is 350 KCAS. Do not exceed 300 KCAS below 10,000' MSL, and if carrying a WSSP Pod, do not exceed 400 KCAS above 10,000' MSL

3.3.2. One technique is to follow the Tech Order Mil Thrust Restricted Climb Schedule using the CLIMB/MAX RANGE CRUISE CHART in the Performance Data Checklist. Use MIL power and pitch as required to achieve the scheduled Mach number for each 5k' altitude step above 10k’ MSL. Note that following the Tech Order climb schedule will require a deceleration to cruise Mach once leveled off at cruise altitude.

3.3.2.1. As a technique, you can use the Divert Mode DVT profile. This will command the CLM airspeed caret to follow the Mil Thrust Unrestricted Climb Schedule, which mirrors the Restricted Climb Schedule above 10,000' MSL. Simply follow the CLM caret to maintain the Tech Order climb schedule. To activate this feature, enter the Destination page of the UFCP by pressing the DST key. Then select UL-1 (DS) and then UL-4 (DVT). Ensure that the DVT profile is displayed on the bottom left corner of the MFD. Press ML-7 on the MFD to change Divert Mode profiles.

3.3.3. Another technique is to climb at your calculated cruise IMN. Calculate your cruise IMN by using JMPS, the Flight Manual Performance Data, or .52 Mach + altitude [in thousands]/100. Accelerate to and climb at this IMN after passing 10,000' MSL. Example: Climbing to 20,000 ft MSL (.52 Mach + 20) = .72 M Cruise IMN.

3.3.4. MAX Power Climb. In full afterburner, an attitude of approximately 20 to 25 degrees nose-high will hold 300 KCAS. Passing 10,000 feet MSL, lower the nose and accelerate to and maintain .9 IMN.

3.3.5. Climb Check**.** You may combine the climb check with the level-off check when cruise altitude is at or below flight level (FL) 180. Applicable steps of the climb check can be completed prior to 10,000 feet MSL; however, the cabin altitude scheduling should be reconfirmed above 10,000 feet MSL.

3.4. Level-Off. The level-off should be a smooth, continuous pitch change to level flight. Avoid abrupt pitch changes and stair stepping to the desired altitude. Normally, a smooth level-off is accomplished as follows: when IVV is less than 6,000 fpm, begin the level-off at 10 percent of the vertical velocity; when IVV is greater than 6,000 fpm, reduce power, lower the nose to cut the picture in half about 2,000 feet prior in MIL power (or 4,000 feet prior in MAX power), and then use 10 percent of the vertical velocity. In addition, the TCAS system was not designed for aircraft with climb performance of the T-38, so be mindful of false RA generation when using high vertical velocities in areas of congested traffic.

3.5. Cruise. Attain cruise airspeed, set power, and trim the aircraft for level flight. A technique for attaining cruise speed at medium/low altitude (<10,000 feet MSL) is to set a fuel flow of approximately 1,200 pounds per hour (pph) per engine to maintain 300 KCAS. Another technique is to use the range (RNG) profile in the emergency divert mode, and fly the commanded calibrated airspeed (CAS) or IMN. When using this technique, pilots must be aware that the aircraft's range mode may command a max range speed which places the aircraft close to the edge of the engine operating envelope. This is more likely to occur at higher altitudes. Above FL280, a Min Mach caret (MM) will appear on the airspeed indicator in the MFD. In all cases when flying above 35,000 MSL, pilots should fly a minimum speed of 0.9 Mach or higher, as indicated by the technical order. Outside air temperature can be determined by referencing the data page on the MFD (select MB1-MB1-ML2 on the MFD). You can also set the flight manual recommended fuel flows for other altitude and airspeed combinations.

3.6. Abnormal Procedures:

3.6.1. Overview. It is not the intent of this paragraph to cover every situation a pilot may encounter, to replace or supersede procedures in the flight manual, or to replace the use of sound judgment. Unusual or complex circumstances will require pilot judgment and systems knowledge to alleviate the situation. In an emergency, the supervisor of flying (SOF), tower personnel, runway supervisory unit (RSU) personnel, and other controlling agencies can assist the pilot. However, if anyone requests information at an inconvenient time, do not allow radio communications or other tasks to distract you from the primary responsibility of flying the aircraft. Take charge of the situation, and don't hesitate to direct controllers to stand by until you are able to safely provide the requested information. When making radio transmissions, be clear, concise, and emphasize exactly what assistance you need. Your priorities are to: ***Aviate, Navigate, Communicate***.

3.6.2. Takeoff Aborts. If there is reason to abort the takeoff, do not hesitate to do so. If the pilot not flying sees something hazardous, he or she will inform the pilot that is flying. If the AC is not flying during a time-critical situation that requires immediate action, and there is no time to relay this to the pilot flying the aircraft, the AC should take control of the aircraft and accomplish the appropriate procedures. The priorities for maintaining directional control are: rudder, differential braking, and nose wheel steering only as a last resort.

3.6.3. Wake Turbulence. Anticipate wake turbulence when taking off behind other aircraft on the same or parallel runways, especially if the wind is calm or straight down the runway. Wake turbulence is formed when an aircraft is creating lift, therefore plan to take off at a point prior to the preceding aircraft's rotation point or after their point of touchdown.

3.6.4. Barrier Operations. Procedures for barrier engagement are specified in the flight manual. The MA-1, MA-1A, and BAK-15 (61QSII) are the only suitable barriers. ***If aborting on a runway where the BAK-15 barrier is raised only on request, transmit "BARRIER, BARRIER, BARRIER" on the appropriate frequency.***

3.6.5. Ejection***. If abandoning the aircraft becomes necessary, the AC will use the command "BAILOUT, BAILOUT, BAILOUT" as the final directive.*** If time and conditions permit, discuss and accomplish ejection procedures with the other crewmember, using the term "ejection" rather than "bailout". In critical situations, do not delay an ejection waiting for the "BAILOUT" command, and do not delay an ejection once the command is given.

3.6.6. Single Engine Taxi. ***Do not taxi the T-38 single engine.*** You may, however, clear an active runway if you have downside hydraulics or the landing gear is pinned.

3.6.7. Transfer of Aircraft Control without Intercom. ***In all cases, transfer of aircraft control should follow procedures found in AFI 11-2T-38, Volume 3.*** Transfer of aircraft control can result in disastrous crew confusion if not done in a positive, previously briefed manner. When the AC assumes control, the other crewmember will immediately relinquish all controls and momentarily show both hands to the AC (use the mirrors as necessary). Normally, the AC will maintain control for the remainder of the flight; however, some circumstances may necessitate a subsequent transfer of control. In these situations, the AC will yaw the aircraft to signal the transfer of aircraft control back to the other crewmember. The other crewmember will acknowledge by shaking the stick and looking for the AC to show hands clear.

3.6.8. Transfer of Aircraft Control during Critical Phases of Flight. During critical phases of flight, maintaining aircraft control often requires rapid intervention by the AC. The possibility exists for both pilots to simultaneously be on the controls until the transfer of aircraft control is complete. Pilots assuming aircraft control must be aware there are other control inputs that can affect the aircraft's performance but are not readily apparent. For example, a pilot assuming aircraft control to abort a takeoff may not be aware that the other pilot has mistakenly depressed the nosewheel steering button. If there is an overlap in aircraft control while the nosewheel steering button is depressed and the throttles are then retarded out of afterburner, the aircraft could enter an unrecoverable skid.

Chapter 4

TRAFFIC PATTERNS AND LANDINGS

4.1. Introduction. High volume traffic patterns require diligent visual lookout and a complete knowledge of traffic pattern procedures. For all patterns, the runway is the primary reference. The flight manual describes the basic procedures for flying the T-38 in the traffic pattern and landing environment. From the flight manual procedures, a variety of techniques can be used to safely and effectively land the aircraft. The remainder of this section outlines the techniques most commonly used and taught in the UFT and pilot instructor training (PIT) environment.

4.2. Judgment in the Traffic Pattern. Your judgment in determining whether an approach is safe must take into account airspeed; aircraft buffet; AOA indications; aural, HUD, and MFD stall warnings; and sink rate. When used together, these indicators can warn you of an approaching stall. Heavy buffet or a high AOA indication in the traffic pattern may indicate one or more of the following conditions: an incorrect configuration, a miscalculated or poorly flown airspeed, too much backstick pressure, or an AOA or airspeed system malfunction. Low airspeed or high AOA may require a go-around. Also, erratic pitch changes can cause momentary flashing of the indexer lights. **Note:** More T-38 fatalities have occurred because of improperly flown final turns than for any other reason. ***If stall indications or an excessive sink rate occur in the traffic pattern, immediately execute a stall recovery. Do not attempt to maintain the traffic pattern ground track because the altitude needed for recovery may significantly increase***.

4.3. Wind Analysis. ***Adjust all traffic patterns to compensate for known wind conditions*.** Use all available wind information to attain adequate downwind displacement during and after the break or pulling closed. Accurate pattern winds can be obtained on the MFD, and surface winds can be obtained from the controlling agency. Compensate for winds on inside downwind by crabbing into the wind to maintain the desired ground track to the perch. As a technique, reference the ground track (GT) indexer to establish the correct crab. With a strong headwind on initial, you should delay the break and begin the final turn earlier than for no-wind conditions. The opposite is true for significant tailwinds on initial. Move your perch point into the wind.

4.4. Normal Straight-In. Normally, slow to approximately 240 knots or less on base or approximately 10 to 15 miles from touchdown on an extended straight-in. Local procedures or traffic deconfliction may require adjustments. Avoid slowing to less than final turn airspeed for the current flap setting until established on final**.** Prior to intercepting the glidepath, establish the landing configuration and trim while allowing the airspeed to gradually decrease to the computed final approach airspeed (approximately .6 AOA). Strive to be configured at final approach speed upon intercepting the glidepath. From this point, follow procedures outlined in "Normal Final Approach" and "Landing Information" this section.

4.5. Normal Overhead:

4.5.1. Normal Break. The end result of the break should be a properly spaced downwind with an established drift correction while maintaining traffic pattern altitude. Unless the controller directs otherwise, ***initiate the break between the approach end and 3,000 feet down the runway.*** Do not go into the break until 45 degrees off from preceding aircraft to ensure 3,000-foot spacing, and abeam another aircraft to ensure 6,000-foot spacing. Ideally, adjust the breakpoint for winds, and vary the bank angle or back pressure during the break to rollout on the desired ground track. Maintain level flight during the break. As a guide, the pitot boom and flightpath marker will be on the horizon during the break turn. A MIL power break turn with AOA and G to reduce airspeed will result in tighter displacement than a reduced power break turn. One technique is to leave the throttles where they are on initial and use AOA and G to reduce airspeed (no wind). ***Slow to below 240 KCAS, but no less than final turn airspeed by rollout.***

4.5.2. Normal Closed Pattern. With clearance for the closed pattern, ***begin the pull-up with a minimum of 240 KCAS***. Normally, power will be in MIL, although a closed pull-up from a go-around may require less power. Execute a climbing 180-degree turn, ***maintaining a minimum of 200 KCAS until wings-level on downwind***. Consider winds (overshooting or undershooting), and establish the proper spacing and crab on rollout. Visually clear for traffic in the break and for other aircraft on downwind.

4.5.3. Normal Inside Downwind. Getting from the break or closed downwind to the perch incorporates pitch, trim, and configuration changes. Check runway displacement when rolling out on inside downwind using the runway as a primary reference and adjust spacing if needed. The normal no-wind spacing is approximately 1 to 1.3 miles for a 1,500 feet AGL traffic pattern (**Figure 4.1**). One technique is to move the spacing reference 0.1 NM (or one finger for visual reference) for every 10 knots of crosswind. Care should be taken when using less than 1.0 NM spacing. As a guide, crab into the wind with twice as much crab as you used on initial. One technique is to have the runway heading set in the CDI course to provide quick heading reference since the canopy rail slopes and can present an illusion. Another technique is referencing the GT caret to maintain the appropriate crab. If the EOR can be selected as the steerpoint, EGI can be used to check runway displacement when abeam the EOR. Compute and verify final turn and final approach airspeeds, and strive to configure no later than abeam the touchdown point. ***Monitor airspeed during flap extension to prevent flap overspeed when lowering full flaps. Prior to beginning the final turn, ensure the landing gear is down and locked and the flaps have traveled a sufficient amount to ensure no asymmetry exists (approximately 60 percent). Maintain a minimum of final turn airspeed.***

Figure 4.1. No-Wind Runway Displacement (1,500 feet AGL traffic pattern).

4.5.4. Final Turn. The goal of a final turn is to arrive over the desired rollout point, on the extended runway centerline, with appropriate heading, altitude, and airspeed. Normally, the rollout point is approximately 300 to 390 feet AGL at 1 to 1.3 NM from the threshold. Begin the final turn when abeam the no-wind rollout point, adjusted for winds. Other reference techniques include: when aligned with the overrun chevron closest to the runway or when reaching approximately a 45-degree angle from the threshold (no wind, assuming 1NM downwind spacing). A preceding T-38 should be two-thirds of the way around the final turn to ensure 3,000-foot landing spacing or abeam for 6,000-foot landing spacing.

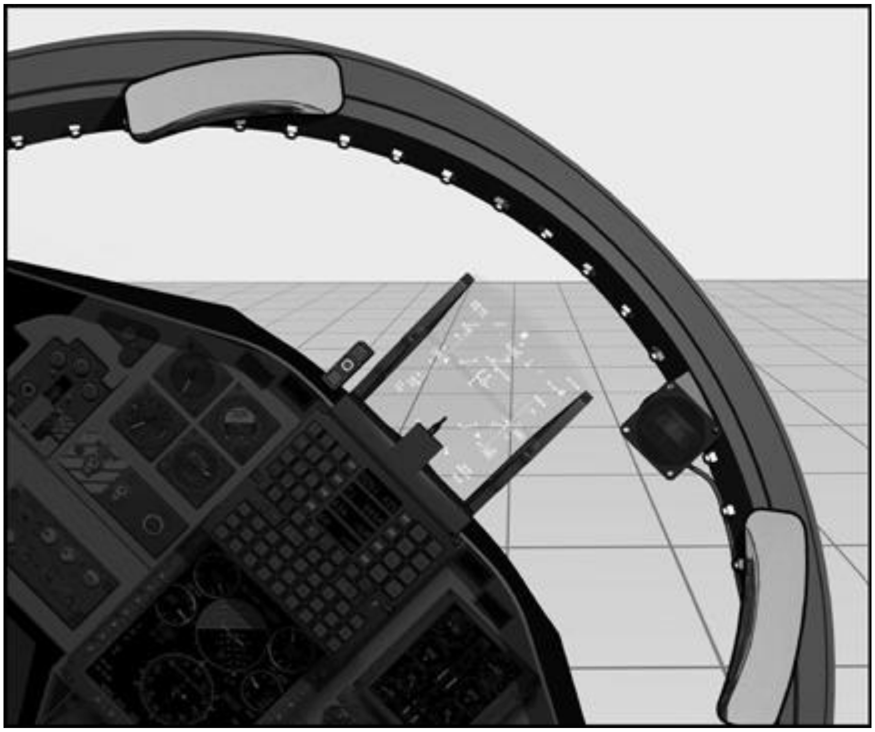
4.5.4.1. Flying the final turn.

4.5.4.1.1. ***Confirm configuration*** and enter approximately a 45-degree banked turn with a shallow rate of descent and blend in back pressure to establish an on-speed AOA. Adjust power, bank, back pressure, and trim to hold final turn airspeed and fly over your rollout point, on altitude, and crabbed into the wind, if necessary***. Maintain approximately .6 AOA throughout the final turn and on final, and do not allow the airspeed to decrease below final turn airspeed until initiating the rollout onto final.***

4.5.4.1.2. A visual reference for pitch in the final turn is two-thirds ground and one-third sky in the front windscreen with the angled portion of the glareshield roughly parallel to the horizon. Also, the top corner of the HUD should be approximately on the horizon (**Figure 4.2**). For a 1,500 ft pattern, the flightpath marker (FPM) will be approximately 6 to 7 degrees nose-low in the HUD/EADI. Whether using the HUD or visual references, the runway remains the primary reference and must be cross-checked in the attempt to intercept a 3-degree glidepath.

4.5.4.1.3. During the early part of the final turn, make a gear-down call. The vertical velocity will eventually indicate approximately double the pattern altitude (approximately 3,000 fpm for a 1,500 ft AGL traffic pattern). Halfway around the final turn, check altitude; you should lose about half the altitude between traffic pattern altitude and rollout altitude with approximately half of your lateral downwind displacement remaining. As a technique, consider the final turn made when <30 degrees of stabilized bank is required, <0.6 AOA required, and within 30 degrees of alignment to the landing runway, power may be reduced to begin slowing to final approach speed corresponding to the amount of bank needed to complete the turn.

Figure 4.2. Normal Final Turn.



4.5.4.2. Rolling Out on Final. Rolling out on final, crab into the wind as necessary, and raise the nose of the aircraft to capture the glidepath based on your desired aimpoint as you slow down. Once established on final and on airspeed, the vertical velocity should be approximately 700 to 900 fpm.

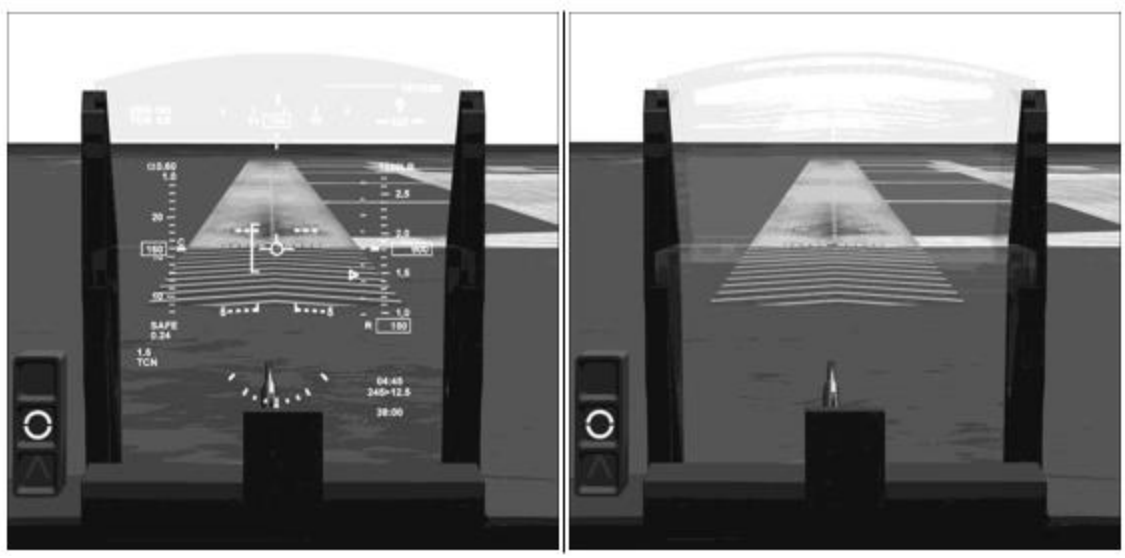
4.6. Normal Final Approach. On final approach, the goal is to maintain the desired glidepath, aimpoint, and final approach speed until transitioning to a flare and landing.

4.6.1. Glidepath**.** Use the runway and surrounding environment as the primary reference for establishing a 2.5 to 3-degree glidepath. Once the proper aimpoint is set, the HUD pitch scale should indicate 2.5 to 3 degrees nose-low with the FPM on the aimpoint. Trim off stick pressures to aid in glidepath control. Corrections to glidepath are made by increasing or decreasing the current pitch until the desired glidepath is regained. If you need to correct for a steep glidepath, aim slightly shorter until re-intercepting a 2.5 to 3-degree glidepath. If you need to correct for a shallow glidepath (being “drug-in”), aim slightly longer until re-intercepting a 2.5 to 3-degree glidepath. In either case, do not allow an excessive descent or sink rate to develop.

4.6.2. HUD OFF Aimpoint (Full Flap). For a normal final approach, the aimpoint will be approximately in the top of the HUD combining glass (the lower piece of glass in the HUD). One technique is to note the FPM position in the HUD; when the HUD is off, use this point.

This will not be a fixed point in the HUD, rather an approximation which varies based on winds, glidepath corrections, etc. The point in the windscreen that appears stationary (it just grows bigger as you approach it) is your true aimpoint. This aimpoint needs to be maintained (assuming on glidepath) until reaching the transition point. When using the HUD, the FPM will help you visualize the aimpoint (**Figure 4.3**).

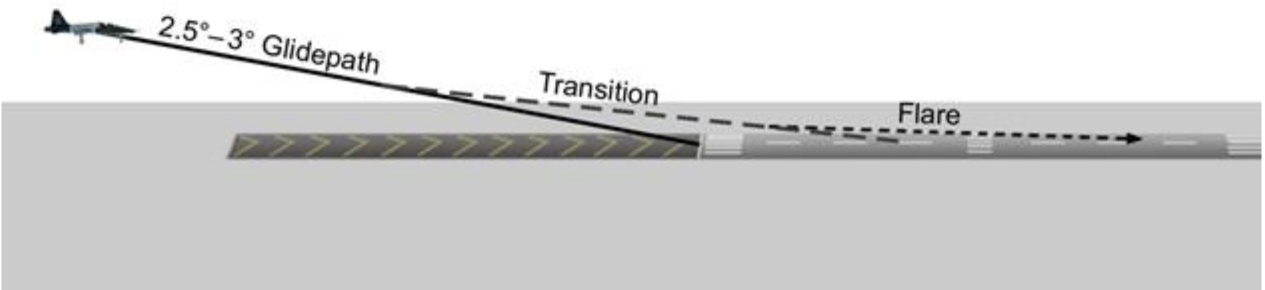
Figure 4.3. Landing Picture (HUD ON and HUD OFF 3 Degree Glidepath).



4.6.3. Airspeed. Ideally, the aircraft should be flown at the computed final approach speed and 6 AOA. ***With gusty winds, increase the final approach and landing speed by one-half the gust factor IAW the flight manual***. Approximately 90 percent rpm will maintain on-speed indications on a normal glidepath with gear and full flaps. When making adjustments to glidepath, a power adjustment may also be required. If there appears to be a calibration discrepancy between the airspeed and AOA indications, take all factors (such as aircraft feel) into account to determine the appropriate speed to fly. Flying a higher speed than required is far safer than attempting to fly on speed with suspect indicators.

4.7. Landing Information. The basics for landing the T-38 involve flying down the glidepath at final approach speed to a desired aimpoint. As the aircraft approaches the aimpoint, the pilot reduces power and transitions the aircraft to level flight, where the aircraft is flared down to touchdown airspeed in ground effect (**Figure 4.4**).

Figure 4.4. Final Approach.



4.7.1. **Glidepath.**

4.7.1.1. The desired glidepath is 2.5 to 3 degrees with an aimpoint at the threshold. A 3-degree glidepath positions the aircraft 300 feet AGL at 1 NM from the threshold.

4.7.1.2. The desired touchdown point may be altered in cases where prudence would dictate a slightly longer aimpoint, such as in runways where there are hazards in the overrun environment, no overrun, or raised lights at the threshold. Generally, an aimpoint 100 to 200 feet past the threshold (around the top of the numbers on an instrument runway) is sufficient to provide a margin of safety and still ensure adequate runway remaining for landing rollout.

4.7.2. Transition. The transition phase is where the pilot transitions from maintaining glidepath, aimpoint, and airspeed to level flight in preparation for the flare. The transition involves both a power reduction and a pitch change. Gross weight, airspeed, winds, height above the runway, descent rate, and AOA affect the timing of the power reduction and the rate of pitch change. As the aircraft completes the transition, it must be positioned at the correct altitude, pitch, and airspeed to flare. A properly trimmed aircraft will require less backstick forces on final, which will make the transition much easier.

4.7.2.1. One transition technique is referred to as "Crack, Shift, Idle, Flare." The timing and application of the four aspects of this technique will vary depending on a variety of factors to include airspeed, glidepath, and wind.

4.7.2.1.1. Crack – At approximately 1,000 feet from the desired aimpoint (typically the threshold), reduce power by pulling back on the throttles approximately 1 inch. If the aircraft is trimmed, the aircraft will try to maintain approach speed. To compensate, backstick pressure must be slightly increased to maintain the flight path marker on the desired aimpoint. Many runways have an overrun of approximately 1,000 feet long to help with this estimate. Another technique for estimating 1,000 feet is to take the distance from the threshold to the "Captain's Bars" and transpose that distance in front of the threshold. Reducing the power in the crack will start the deceleration process.

4.7.2.1.2. Shift – Approximately 500-750 feet from the threshold, apply slight backstick pressure to move the flight path marker to 100-200 feet beyond the threshold (or other previous aimpoint). This will slightly shallow out the glidepath while continuing to aid the deceleration process.

4.7.2.1.3. Idle – Approximately 300-500 feet from the threshold, reduce power to idle. The power pull should be adjusted to make the aircraft cross the threshold at 5-10 knots below calculated approach speed.

4.7.2.1.4. Flare – As the aircraft approaches the ground, smoothly apply backstick pressure, raising the flight path marker to level to stop descending and maintain level flight with the main landing gear 1-2 feet above the ground. As the aircraft continues to decelerate, more backstick pressure will be required to maintain level flight. As the aircraft approaches touchdown speed (20-25 knots below approach speed), the aircraft will settle to the ground.

4.7.2.2. Another technique is to begin a smooth, gradual power reduction by “latching the throttles” to the threshold so that power is pulled at the same rate the threshold is approaching. Using this technique, the aimpoint is initially shifted the same as above.

4.7.2.3. For a landing 150 to 1,000 feet down the runway, the aircraft should cross the runway threshold approximately 5 to 10 feet off the ground and 5 to 10 knots below final approach speed. As the aircraft approaches the desired height above the runway, raise your eyes to the other end of the runway and increase backstick pressure to smoothly arrest the descent. The aimpoint will continue to shift down the runway. Shifting your eyes helps you pick up peripheral cues to judge and arrest descent at the right height. It will also help you maintain directional control, especially during crosswinds.

4.7.2.4. If the glidepath is steeper than normal, a greater pitch change will be required to arrest the descent. With a larger pitch change, the pilot must delay the power reduction until a normal transition line is established.

4.7.2.5. If you are coming in from below a normal glidepath, power should be held until a normal transition line is established (at which point the rules of thumb listed above apply). If buffet is felt during the transition, delay the power reduction or consider adding power as required to avoid stall indications.

4.7.2.6. Premature touchdowns can result from insufficient backstick pressure in the transition, early or rapid power reduction causing a sink rate, or an incorrect perception of aircraft height and descent rate. ***If an excessive sink develops, execute a stall recovery.*** With a strong headwind or gusty crosswinds, use caution when reducing power to idle.

4.7.2.7. Long, fast touchdowns can result from a delayed or slow power reduction.

4.7.2.8. Sinking flares, firm touchdowns, or hard landings can result from excessive height at the end of the transition. Excess height results when: the transition is started too high (shifting the aimpoint early); back pressure is applied too rapidly (shifting the aimpoint too fast); airspeed is carried too long; or height is not judged correctly.

4.7.3. Flare and Landing. The flare is where the aircraft remains in level flight and dissipates kinetic energy to slow to touchdown speed. Since power is reduced to idle during the transition, remaining in level flight involves a pitch change as the airspeed decreases. Ideally, the aircraft reaches touchdown speed in the landing attitude as the main gear smoothly touches the runway (fully flared) approximately 150 to 1,000 feet down the runway. Landing deviations can result from conditions established in the transition or from flare execution.

4.7.3.1. A low height at the end of the transition or insufficient back pressure to maintain level flight during the flare causes premature (early or short) touchdowns.

4.7.3.2. Excessive back pressure during the flare, with sufficient airspeed, causes the aircraft to balloon. If this happens, consider if a go-around is required. Otherwise, momentarily relax back pressure, reestablish the correct height, and continue the flare to landing.

4.7.4. Heavy Weight Landing. The speed reduction from final approach speed to landing speed is the same for the lightweight and heavyweight landing (approximately 25 knots). However, the power reduction may need to be slower (or later) to prevent slow airspeed, a sink rate from developing, or landing short. If the pilot is not certain that the sink rate has been adequately reduced, the power reduction will have to be delayed, and a longer and (or) faster touchdown will result. This may indicate that a go-around for stopping distance is required.

4.7.5. Landing on Alternate Sides of the Runway. When traffic permits, land in the center of the runway. However, during a busy traffic pattern or when using reduced runway separation, plan the final approach and landing using alternate sides of the runway, keeping the aircraft toward the center. When landing on alternate sides of the runway, position the runway centerline between the main landing gear and wingtip opposite the side of the runway you are landing on. For example, on the right side of the runway land with the centerline between left main landing gear and left wingtip. Don’t allow the aircraft to drift across the runway centerline. We refer to the two sides of the runway as hot side (the side of the runway opposite the turnoff taxiways) and the cold side (the side of the runway adjacent to turnoff taxiways).

4.7.6. Visual Glide Slope Indicators. Approach lighting systems, including visual approach slope indicator (VASI) and precision approach path indicator (PAPI) systems, can help establish a safe glidepath. For normal transition approaches where the aimpoint is the runway threshold, these systems are good for reference 3 to 4 miles out, but will show below glidepath indications inside approximately 1 mile.

4.7.6.1. Standard VASI and PAPI. The standard VASI and PAPI have a 2½- to 3-degree glideslope and a glidepath intercept point (aimpoint) approximately 750 feet beyond the runway threshold. The glidepath is normally coincidental with the ILS or precision approach radar (PAR) glideslope. When flying the standard VASI or PAPI glidepath down to the flare, expect to land up to 2,000 feet down the runway. This is normally not desired during a normal transition approach where you want to land 150 to 1,000 feet down the runway.

4.7.6.2. Other Approach Lighting Systems. Some Air Force bases use the Pulsating Visual Approach Slope Indicator (PVASI) and most naval air stations use the Fresnel Lens Optical Landing System (FLOLS). Refer to *Flight Information Publications (FLIP)* for complete guidance on these systems.

4.8. Full Stop Landing and Aerobrake.

4.8.1. ***Ensure the throttles are in idle*** . On a full-stop landing after touchdown, smoothly increase back pressure to attain approximately a 10 to 12-degree pitch attitude for an aerobrake. A technique is to place the bore sight cross slightly above the 10-degree nose-high reference line. Just prior to the loss of stabilator authority, lower the nosewheel to the runway. Aerobrake as appropriate for gross weight (e.g., with 1,000 pounds of fuel remaining, the maximum attitude of 12 degrees can be achieved at about 130 KCAS). Do not aerobrake abruptly—a lightweight T-38 can be pulled dangerously into the air.

4.8.2. Smoothly fly the nose to the runway approaching 100 KCAS. Heavyweight aircraft stopping characteristics are different than lightweight characteristics. The aerobrake can begin at a faster calibrated airspeed, and the nose will settle to the runway sooner following the aerobrake. Because the touchdown airspeed is higher, the stopping distance is longer and the wheel brakes will initially feel less effective. After lowering the nosewheel to the runway, keep the stick full aft to increase weight on the main gear and use cautious wheel braking to prevent possible skidding.

4.8.3. Approximate normal landing distance is computed by adding 2,500 plus the fuel from the touchdown point. For example with 1,200 lbs (2,500 + 1,200) + 500-1,000 ft touchdown point = 4,200-4,700 ft runway required.

4.9. Rollout and Wheel Braking.

4.9.1. During a landing roll, apply aileron into the wind, and maintain directional control with the rudder. After lowering the nosewheel, check for brake system pressure by gently pressing the brake pedals. To prevent possible directional control problems, make sure both pedals are applied with equal pressure in one smooth brake application. Do not pump the brakes unless a single application provides insufficient pressure.

4.9.2. Use steady braking to reduce to taxi speed. Keep the stick full aft until 50 KIAS to maximize aerodynamic deceleration. Maintain directional control with the rudder and differential braking until you reach taxi speed, then use nosewheel steering. When routinely operating from very long runways, practice the braking technique required to stop on shorter runways. A technique is to use three times the speed of the remaining runway in thousands of feet to estimate if the appropriate braking has been used. For example, your ground speed should be no greater than 90 knots for 3,000 feet remaining, 60 knots for 2,000 feet remaining, and 30 knots for 1,000 feet remaining.

4.9.3. When landing in the center of the runway or on the hot side, plan to cross to the cold side with speed under control and sufficient distance down the runway to prevent a conflict with other traffic. If turning off the runway prior to the end, clear for aircraft behind you on the runway before crossing to the cold side. Comply with local procedures.

4.10. Touch and Go Landing.

4.10.1. At touchdown, advance power to MIL (or MAX, if required) and smoothly lower the nose slightly below takeoff attitude to just prior to the nosewheel touching the runway. Do not release backstick pressure abruptly. Check the engine instruments, and accelerate to takeoff airspeed.

4.10.2. When reaching takeoff speed (approximately final approach speed), establish the takeoff attitude, and allow the aircraft to fly off the runway. Then follow initial takeoff procedures. High gross weights, high temperatures, high-pressure altitudes, full flaps, etc., may adversely affect acceleration. Consider selecting afterburner under these conditions. Another technique is to retract the flaps to 60 percent until reaching 200 KCAS to avoid losing altitude as the flaps are retracted beyond 60 percent.

4.11. Crosswind Landing:

4.11.1. Final Approach. Counteract the drift by crabbing into the wind. ***Maintain the crab until touchdown.*** The aircraft will reduce the crab angle when both main tires are on the ground. ***When the crosswind component exceeds 15 knots, plan to touch down on the upwind side of the runway.***

4.11.2. **Full-Stop Landing:**

4.11.2.1. ***When the crosswind component exceeds 15 knots, maintain the landing attitude and do not aerobrake.*** Maintaining the landing attitude requires additional backstick pressure as airspeed decreases. Increasing backstick pressure too rapidly may result in the aircraft becoming airborne or drifting across the runway.

4.11.2.2. Tire damage is highly probable if you allow the aircraft to drift across the runway by not applying aileron into the wind. Maintain directional control with the rudder. Applying aileron into the wind will aid in directional control, help prevent compression of the downwind strut, and prevent the upwind wing from becoming airborne.

4.11.2.3. Just prior to the loss of stabilator authority, lower the nosewheel to the runway and apply aileron into the wind. Do not lower the nose prematurely with a crosswind. Insufficient crosswind controls may result in compression of the downwind strut and poor directional control and, when combined with weathervaning, can result in damage to the downwind tire.

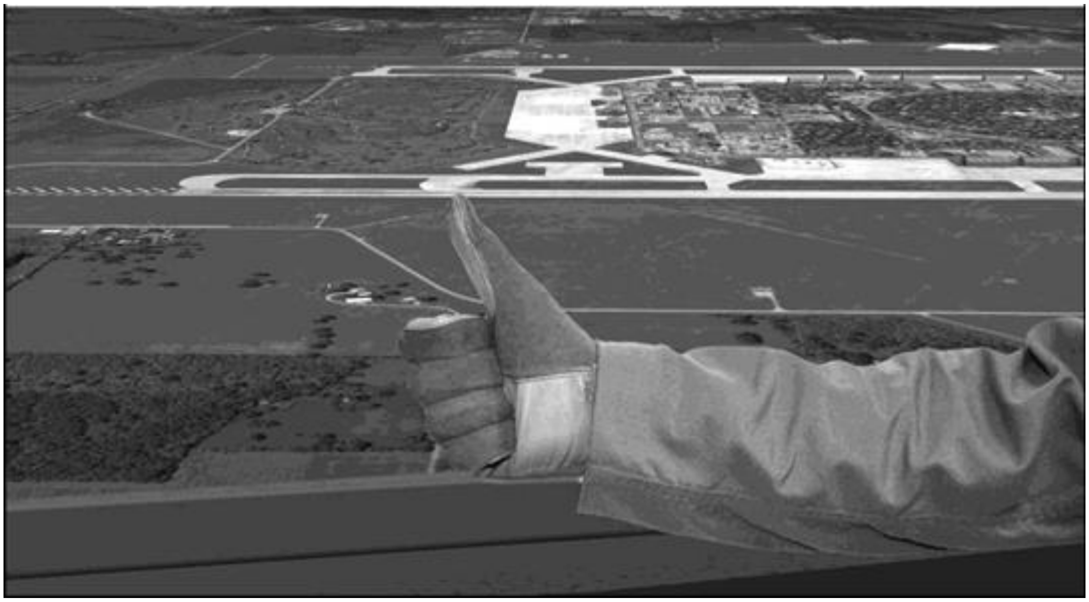
4.11.2.4. Applying these techniques during crosswind landings may increase the landing distance by approximately 50 percent. Expect to be farther down the runway when you lower the nose, with less runway remaining to stop the aircraft.

4.12. No-Flap Patterns and Landings:

4.12.1. No-Flap Straight-In. Practice a no-flap straight-in to prepare for an actual emergency that requires a no-flap landing. The basic procedures for flying the approach are the same as the normal straight-in.

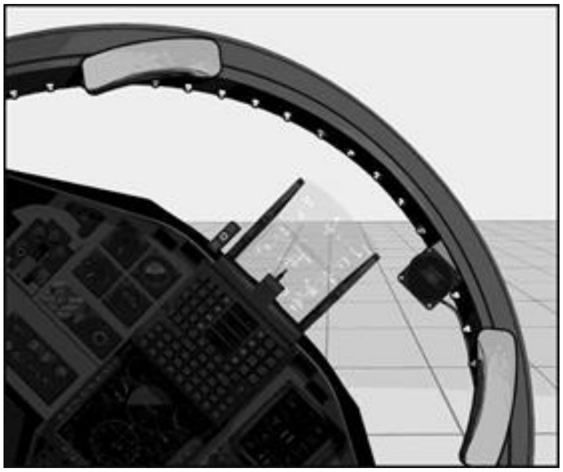
4.12.2. No-Flap Overhead. The reason we do no-flap overhead patterns is to maximize no-flap landing training. For an actual emergency requiring a no-flap landing, a straight-in approach should be flown. Due to the increased final turn airspeed and resulting increased turn radius, the no-flap pattern requires a wider downwind displacement. The no-flap no-wind spacing is approximately 1.5 miles for a 1,500 feet AGL traffic pattern (Figure 4.5). One technique is to move the spacing reference 0.1 NM (or one finger for visual reference) for every 10 knots of crosswind. Care should be taken when using less than 1.5 NM spacing.

Figure 4.5. No-Flap Runway Displacement (1,500 feet AGL traffic pattern).



4.12.2.1. Flying the No-Flap Final Turn. The desired rollout point for a no-flap final turn is the same as for a normal overhead. Realize you're wider on a no-flap; therefore, if you use the same visual reference (in relation to the runway) to begin the turn as on a normal pattern, you will be too long at the perch. ***Confirm configuration*** and enter approximately a 45-degree banked turn. Let the nose of the aircraft fall very slightly, and smoothly add back pressure to establish an on-speed AOA. The visual reference for a no-flap final turn is approximately half ground and half sky with the angled portion of the glareshield roughly parallel to the horizon (**Figure 4.6**). The horizon should approximately touch the top corner of the combining glass. In a 1500 ft pattern, the FPM will be approximately 4-to 6-degrees nose-low in the HUD; however, the aircraft pitch attitude will be higher than what you see during the normal final turn. Trim to reduce stick pressure as pitch and airspeed are changed. Maintain approximately .6 AOA throughout the final turn and on final, and do not allow the airspeed to decrease below final turn airspeed until initiating the rollout onto final.

Figure 4.6. No-Flap Final Turn.



4.12.2.2. Rolling Out on a No-Flap Final Approach. As you rollout on final, reduce power to attain final approach airspeed as soon as practical. Because of the reduced drag with flaps up, you will need a larger power reduction to slow at the same rate as an aircraft configured with full flaps. Without the flap/slab interconnect, more aft stick travel is required to arrest the sink rate as the glidepath is captured.

4.12.3. No-Flap Final Approach:

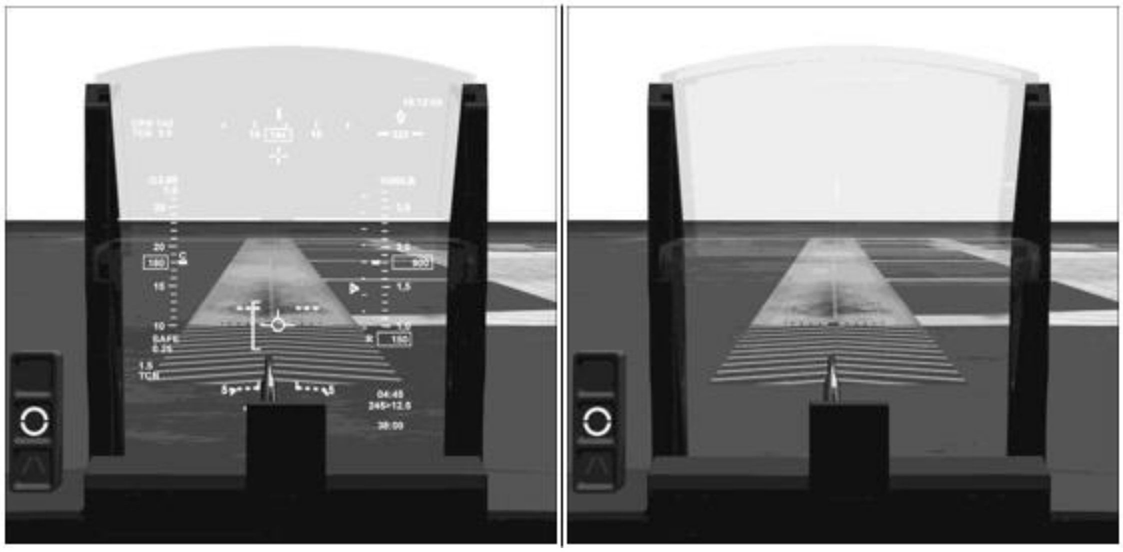
4.12.3.1. HUD OFF Aimpoint (No-Flap). For a no-wind, no-flap final, place the desired aimpoint about one-third of the way up from the bottom of the HUD, or slightly above the top of the AOA indexer (Figure 4.7). Trim off backstick pressure, and monitor aimpoint, airspeed, and glidepath. The transition and landing phases are the same as a normal landing with the exception of pulling the power to idle. Because of the reduced drag without flaps, power reduction normally needs to begin 300 to 500 feet sooner than on an approach with full flaps. Exercise diligence when reducing power and transitioning to the flare to avoid a sink. Without the flap/slab interconnect, more aft stick travel is required to achieve the desired pitch change, arrest the sink, and flare.

4.12.3.2. Due to higher landing speed and less effective aerobraking on a no-flap approach and landing, expect landing distances to be approximately twice the landing distance of a normal landing at similar fuel weights. Reference the no-flap landing checklist in an actual emergency.

4.12.3.3. Calculated no-flap landing distance is computed by adding 2,500 plus the fuel from the touchdown point and multiplying it by two. For example with 1,200 lbs 2 x (2,500 + 1,200) + 500 ft touchdown point = 7,900 feet runway required.

4.12.3.4. When the crosswind component exceeds 15 knots, apply the crosswind landing procedures shown in paragraph 4.11. The no-flap crosswind landing distance will be longer than most runways.

Figure 4.7. No-Flap Landing Picture (HUD ON and HUD Off).



4.13. Single-Engine Patterns and Landings:

4.13.1. Single-Engine Pattern. ***Fly single-engine patterns from a straight-in approach. Set the simulated failed engine not less than 60 percent rpm during a simulated single-engine approach***. Power on the good engine will be approximately 98 percent on glidepath. ***Use the rudder to counteract the yaw induced by asymmetrical thrust*** ("step on the good engine"). Yaw will be greater during low- airspeed, maximum-thrust situations such as a single-engine go-around. Once established on a 2.5 to 3-degree glidepath, take out the rudder input and accept mildly uncoordinated flight as to not induce a rolling moment in the flare due to increasing rudder effectiveness as backstick pressure is applied.

4.13.2. Single-Engine Landing. The single-engine landing is similar to the normal landing with the following exceptions: With 60 percent flaps selected, drag is not as great as with full flaps, and power must be reduced slightly sooner than a full flap landing under the same conditions to touch down in the same location. However, use caution to prevent landing short of your desired touchdown point. ***Ensure both throttles are checked in idle for touchdown.*** When performing an actual or simulated single-engine full-stop landing with 60 percent flaps, the landing roll will be approximately 500 feet longer. If heavy weight or if landing distance is critical, consider using full flaps when landing is assured according to the flight manual.

4.13.3. Touch-and-Go from a Single-Engine Landing. ***Use both engines for the takeoff following a simulated single-engine touch-and-go landing.***

4.13.4. Go-Around from a Single-Engine Approach. ***If a go-around is required for any reason other than a planned single-engine go-around practice, use both engines.*** Refer to paragraph 4.14 for single-engine go-around practice procedures.

4.13.5. Single-Engine Safety Considerations. Heavy fuel loads, high outside air temperatures, high pressure altitudes, or a combination of these conditions makes single-engine approaches more difficult. These conditions may also result in MIL power being insufficient to maintain level flight while configured. If these conditions exist, consider configuring the aircraft just prior to intercepting the glideslope. Use afterburner if needed to maintain final approach speed on final.

4.14. Practice Single-Engine Go-Around:

4.14.1. The setup and planned execution should be pre-briefed, and may be accomplished from either a straight-in or overhead pattern. The aircraft should be stabilized on final at final approach airspeed ***with the simulated inoperative engine set no less than 60 percent rpm***.

4.14.2. If the single-engine go-around is practiced from an overhead pattern, fly the final turn portion of the pattern with 60 percent flaps or full flaps, ***using both engines until rolling out on final***. Once on final, simulate the engine failure, and then apply the boldface to initiate the go-around. Use coordinated rudder to offset the adverse yaw produced by one engine in afterburner. ***Once the simulated single-engine go-around exercise is complete, advance the simulated inoperative engine to MIL prior to coming out of afterburner on the other engine.*** If an unsafe situation is developing, do not hesitate to abandon a simulated single-engine go exercise and ***recover the aircraft using both engines.***

4.15. Low-Closed Traffic Pattern. Use a low-closed traffic pattern to practice circling approach procedures. The procedures for a low-closed pull-up are the same as for the normal closed pull-up except you must adjust the pull-up to attain the published low-closed altitude and a wider downwind displacement. Be aware of the reduced power and pitch requirements since the downwind altitude is lower. From the downwind position, fly the practice circling approach as described in **Chapter 7**.

4.16. Traffic Pattern Irregularities.

4.16.1. Excessive Sink Rates:

4.16.1.1. Excessive sink rates are insidious and potentially deadly in the traffic pattern. If allowed to continue, recovery may not be possible due to engine response time, lack of excess thrust, and (or) insufficient altitude.

4.16.1.2. Excessive sink rates are generally not accompanied by approach to stall indications. Vertical velocity is the primary indication of excessive sink rate.

4.16.1.3. In the final turn from a standard 1,500-foot overhead pattern, a vertical velocity in excess of twice the pattern altitude is normally an indication of an excessive sink rate condition. On short final approach, vertical velocity of approximately 700-900 fpm is normal. Anything greater may be an indication of excessive sink rate. In most mishaps the sink rates developed first, and were followed by a stall during the recovery. **Note:** ***Any time you encounter an excessive sink rate in the traffic pattern, immediately execute a stall recovery.*** Proper stall/sink rate recovery procedures take priority over maintaining the published ground track.

4.16.2. Stall Indications in the Traffic Pattern:

4.16.2.1. An actual stalled condition is immediately preceded by heavy, low-frequency buffet, and in most cases, moderate wing rock. The actual stall is indicated by a combination of a very high sink rate, heavy buffet, and high AOA (above 1.0). Training and recovery techniques must concentrate on approach-to-stall characteristics to prevent an actual stall.

4.16.2.2. Individual aircraft performance may differ. The sequence of flight characteristics up to and beyond the approach-to-stall indication include:

4.16.2.2.1. Light Buffet. The light buffet is defined as the buffet at 0.6 AOA (green donut). This is the optimum final turn AOA.

4.16.2.2.2. Moderate Buffet. Moderate buffet is the buffet from approximately 0.7 AOA to the definite increase in buffet intensity. (Red chevron above green donut).

4.16.2.2.3. Definite Increase in Buffet Intensity (DIBI). The definite increase in buffet intensity is the point where the buffet increases in amplitude, but the frequency becomes slower and irregular. Wing rock may occur. This typically occurs in excess of 0.8 AOA.

4.16.2.2.4. Heavy Buffet. Heavy buffet is the buffet from AOA higher than the definite increase in buffet intensity to the point where the stick is at the aft stop.

4.16.2.2.5. The aural, HUD, and MFD stall warnings (a boxed, blinking, STALL warning displayed on the HUD and MFD, and a stall warning tone, when the landing gear is extended and the AOA is at or above 0.80).

4.16.2.2.6. Low-frequency, high-intensity airframe buffet.

4.16.2.2.7. Glareshield shaking, erratic buffet (no set frequency).

4.16.2.2.8. Wingtips stall first and may cause a wing to drop.

4.16.2.2.9. Light wing rock due to alternately stalling wingtips.

4.16.3. Recovery Procedures for Stall, Approach-to-Stall, or Excessive Sink Rate:

4.16.3.1. ***In the traffic pattern, execute the stall/sink recovery any time you encounter a definite increase in buffet intensity or aural, HUD, and MFD stall warnings, or excessive sink rate. Simultaneously advance both throttles to MAX, relax backstick pressure as required, and roll the wings level*** . Rudder can be an effective way to initiate the roll to wings level; however, use caution to avoid over-controlling. Approaching wings level, maintain an AOA just below the definite increase in buffet intensity and achieve a positive nose track until establishing a climb. **Note:** Maintaining an AOA just below the definite increase in buffet intensity may activate the aural, HUD, and MFD stall warnings.

4.16.3.2. Once a safe climb has been established and obstacle clearance is assured, relax backstick pressure to allow the aircraft to accelerate. Avoid heavy buffet or secondary stall during the recovery. Since decreasing bank significantly reduces the stall speed, do not delay raising the nose after the wings are level. Airspeed can also be used as an indication of maximizing performance. In general, excess thrust during recovery should be used for establishing a climb versus increasing airspeed. Therefore, airspeed should not increase during the recovery, but should remain constant (not decrease).

4.16.4. Avoiding Stall/Sink Rate Situations. Avoiding situations that can lead to a stall/sink rate is the best way to prevent one. Four pilot-controlled variables determine controlled patterns—attitude, airspeed, configuration, and power. When one or more of these variables is flown incorrectly, pilots tend to allow a sink rate to develop in order to hold the other variables in the optimum range. For example, a pattern can appear normal in every respect as long as the pilot allows a sink rate to compensate for an improperly set bug speed. Any combination of situations can rapidly deteriorate into a stalled or sink-rate condition without exaggerating any single condition. Some of these situations include the following:

4.16.4.1. Beginning the final turn with an improper configuration.

4.16.4.2. Beginning the final turn with less than the computed final turn airspeed.

4.16.4.3. Beginning the final turn with inadequate downwind displacement.

4.16.4.4. Beginning the final turn with an excessively nose-low attitude.

4.16.4.5. Flying a stabilized final turn with more than 0.6 AOA or 45 degrees of bank.

4.16.4.6. Using low power settings.

4.16.4.7. Making abrupt control movements.

4.16.4.8. Overbanking to correct an overshooting final turn.

4.16.5. Rudder Overcontrol. When configured, the T-38's 30 degrees of available rudder is highly effective in rolling the aircraft. Although the rudder is not needed to coordinate flight, it may be useful during high AOA or asymmetric thrust situations. To prevent over-control, use only small rudder inputs as required in the traffic pattern. In no case should you wait until you see aircraft response before removing rudder input when the landing gear are extended.

4.16.6. Balloons, Bounces, and High Flares:

4.16.6.1. Balloons, bounces, and high flares are the result of abrupt control inputs in the transition and flare or a misjudgment of the height above runway. They can all result in the same dangerous situation—an aircraft above the runway with insufficient airspeed for a controlled descent.

4.16.6.2. In mild cases, they may only result in a firm landing. In extreme cases, they can result in a wing rock, wingtip contact with the runway, or departure from the prepared surface.

4.16.6.3. For minor deviations, reestablish the landing attitude and continue with a flare and touchdown. You may need to fly the aircraft back to the runway or accept a hard landing and (or) bounce while waiting for acceleration. In all cases, use extreme caution to avoid approach-to-stall indications or wing rock. Recovery should appear much like a landing attitude stall recovery with most of your concentration focused on keeping the wings level and flightpath down the runway. ***For larger or more pronounced deviations, immediately perform a go-around. Simultaneously select MIL or MAX power and establish a safe pitch attitude.***

4.16.7. Over rotation. An abrupt or excessive application of backstick pressure during a takeoff usually causes over rotation. However, during a touch-and-go landing, maintaining the landing attitude while increasing the power may also cause over rotation. Over rotation can lead to a premature liftoff at a potentially dangerous airspeed. To correct this situation, establish the normal takeoff attitude, select MAX if necessary, and allow the aircraft to accelerate. It may be necessary to allow the aircraft to settle back to the runway to accelerate in a three-point attitude to attain safe flying airspeed and avoid approach to stall indications.

4.17. Go-Around:

4.17.1. Go-Around from the Final or Landing Phase. Advance power to MIL (MAX, if required), accelerate to a minimum of final approach airspeed, and retract the landing gear only after ensuring touchdown will not occur. Ensure sufficient airspeed exists before retracting the flaps. Climb, following local procedures for ground track and altitudes. Use caution not to overspeed the gear, gear doors, or flaps. If the runway is clear, you do not have to offset to the side of the runway.

4.17.2. Go-Around from the Final Turn:

4.17.2.1. On a go-around from the final turn, the potential for gear or flap overspeed is high. Therefore, cross-check your flight parameters during the go-around. MIL is not always required in these situations. To execute a go-around from the final turn, maintain a minimum of final turn airspeed, climb or descend as required, and retract the gear and flaps only after attaining a safe flying airspeed. If the runway is clear, you do not have to offset to the side of the runway. Maintain 240 to 300 KCAS on the go-around.

4.17.2.2. With the aircraft under control and if time permits, notify the RSU or tower when initiating a go-around. ***Never break out from the final turn;*** execute a go-around instead. Consider lowering flaps to 60 percent when going around from an overshooting, no-flap final turn. ***If a dangerous situation develops, do not attempt to conform to the prescribed traffic pattern ground track.*** Your first priority is to maintain aircraft control.

4.17.3. Touching Down During a Go-Around. If an airborne go-around is impossible, continue to fly the aircraft to touchdown. Do not attempt to hold the aircraft off the runway in a nose-high attitude. Instead, maintain the landing attitude and accept a touchdown. Then perform a takeoff in the same manner as the takeoff phase of a touch-and-go landing, using MAX power if necessary.

4.18. Alternate Gear Extension. Allow extra time for the gear extension when using the alternate system. ***After practicing an alternate gear extension, ensure the alternate release handle is fully stowed. Then reset the landing gear system. Accomplish this by moving the landing gear handle down, then up, and then back to the down position.*** When accomplishing an alternate extension, lower the flaps, as required, before lowering the gear IAW the flight manual.

4.19. Abnormal Procedures:

4.19.1. Alternate Gear Extension. Under conditions requiring alternate gear extension, the front cockpit pilot must be prepared to lower the landing gear with the alternate gear release handle. Without intercom, the rear seat occupant may signal the need to use the alternate gear release system by lowering the landing gear handle.

4.19.2. Airspeed Indicator Malfunction. With a known or suspected airspeed indicator malfunction, ensure the pitot heat is on, and establish a known power setting or fuel flow for the desired cruise airspeed, and refer to your checklist. If the airspeed malfunction is caused by an ADC failure, there will not be an AOA to reference. If possible, use a chase aircraft for recovery. If one is not available, use known power settings and (or) fuel flows in combination with the AOA system to approximate desired airspeeds. (A 0.3 AOA equals 230 + gas; a 0.5 AOA usually indicates a safe gear-lowering speed.) You can use the AOA system to safely recover the aircraft because it is independent of the pitot static system. Ground speed should still be displayed on the MFD and can be used to approximate airspeed.

4.19.3. Bird Strike. A bird strike poses a hazard to low-altitude operations, particularly in the traffic pattern and on low-level navigation routes. The two most serious forms of damage from bird strikes are engine failure and cockpit penetration. In the traffic pattern, consideration must be given not to make an aggressive bird avoidance maneuver that may lead to a more severe stall or ground impact situation. Due to the critical nature of cockpit penetration, thoroughly brief procedures for transfer of aircraft control and reestablishment of intercockpit communications.

4.19.4. Go/No-Go Decisions from a Touch-and-Go Landing. Although TOLD for touch-and-go landings is impractical, the following rules of thumb are useful:

4.19.4.1. Normally, at or near the point of touchdown, both an abort and a takeoff are safe options, even with a single-engine failure. The abort is possible because the aircraft is lighter than on initial takeoff. Barring a catastrophic, compound problem, the takeoff is equally safe. At touchdown, the aircraft is no more than 25 knots below final approach speed with most of the runway remaining. In most cases, either option will work, provided you stick to your original decision and correctly apply the procedures.

4.19.4.2. For a no-flap touch-and-go, an abort requires further consideration. By regulation, the landing fuel weight will be below 2,500 pounds. According to the flight manual, the stopping distance for a no- flap landing is approximately 2 x (2,500 + fuel weight). For fuel weights closer to 2,500 pounds, the stopping distance from the actual touchdown point could exceed actual runway available. A takeoff decision in this scenario should be the safer option.

4.19.4.3. The go/no-go decision is largely a matter of pilot preference, but the most common technique is to consider the throttle position. That is, if the throttles are in idle when the problem occurs, leave them there because you are psychologically prepared to land. However, if you have advanced the throttles or they have stabilized in MIL power, consider continuing the takeoff. ***In either case, apply the appropriate boldface for the selected decision.***

4.19.4.4. As with other emergency situations, you should weigh all factors, including the runway remaining, runway condition, configuration, aircraft weight, weather, barrier type, and obstacles on departure. In any case, two fundamental questions will serve you well: (1) is a safe abort possible? And (2) is a safe takeoff possible? Take the time to answer these questions on the ground—before you fly. This discussion highlights why we emphasize landing on speed in the desired landing zone—to provide maximum runway remaining to stop (or go) during an emergency.

4.19.4.5. After-Landing Procedures with an Emergency. If you need assistance from fire department or maintenance personnel following an emergency landing, hold the brakes and raise both hands. This signals to the ground crew that they are clear to inspect the aircraft. ***Do not actuate switches without visual coordination with the ground crew.***

Chapter 5

TRANSITION

Section 5A—General Methods and Procedures

5.1. Introduction. Transition flying in the T-38 incorporates areas of training in which pilots learn and practice the basics, including takeoffs, landings, and a wide variety of area work. Transition training is flown single ship, with an emphasis on using primarily outside, visual references—the horizon, ground, runway, etc. The basic objective of transition flying in the T-38 is to build a solid feel for the aircraft's performance capabilities through a large portion of its flight envelope, including stalls, aerobatics, advanced handling characteristics, and normal and emergency traffic patterns.

5.2. Area Orientation. Maintain area orientation using all available means (ground references, NAVAIDs, or horizontal situation display [HSD]). Ground references should be the primary reference, when available. There are three methods of using the aircraft instruments—HSD, center radial, and pie- in-the-sky as follows:

5.2.1. HSD/SIT Method. The HSD/SIT can depict flying zones based on the data transfer system (DTS) load. With the correct area boundaries depicted on the HSD/SIT, turn as required to maintain the aircraft symbol within the confines of the depicted flying training zone boundaries. Select an HSD/SIT range which allows sufficient detail to determine proximity to borders and turn direction. Normally, 15 or 30 NM ranges will be sufficient. Momentarily increasing the display scale can prevent confusion when trying to discern between training zone boundaries.

5.2.2. Center Radial. The center radial technique is best used in narrow areas (20 radials wide or less). With the center radial dialed in, the center of the area is always toward~~s~~ the CDI.

5.2.3. Pie-in-the-Sky. The pie-in-the-sky technique is best used in wide areas (20 radials wide or more). Dial in one course boundary bearing (not radial), and mark the other course boundary bearing with the heading marker. Keep the head of the bearing pointer—which always falls—between the head of the course arrow and the heading marker.

5.3. Energy Management:

5.3.1. **General.** Energy management requires maintaining effective combinations of altitude, airspeed, power settings, and AOA or G loading. Airspeed provides the kinetic energy required to maneuver the aircraft. Altitude provides potential energy that may be exchanged for airspeed. Power settings, AOA and G loading control can be used to gain or lose energy.

5.3.2. Exchanging Altitude and Airspeed. Altitude and airspeed can be traded at a given rate. The most common rule of thumb is 1,000 feet of altitude is worth about 50 knots of airspeed. You can exchange altitude and airspeed in these proportions by using MIL power with the canopy bow on the horizon or 80 to 85 percent rpm at 20 degrees nose-high.

5.3.3. Optimum Energy Level. To do aerobatic maneuvering in a standard UFT or PIT military operations area (MOA), the optimum energy level allowing you to do nearly all maneuvers is 300 KCAS at an altitude midway between the top and the bottom of the MOA. Minimum and equivalent energy levels (the altitude-airspeed relationship) may be calculated using the 50 knots at 1,000 feet exchange rate rule shown earlier in paragraph 5.3.2. For example, 16,000 feet MSL at 300 KCAS is approximately the same energy level as 14,000 feet MSL at 400 KCAS.

5.3.4. Losing Energy. Losing energy is easy through the use of low power settings, increased drag due to configuration or speed brakes, and (or) increased AOA/G loading. A simple way to lose energy is to perform a constant speed descent until the desired energy level is reached. Applying increasing back stick pressure until achieving moderate buffet (see paragraph 5.7.3) will also help lose energy. Use caution to avoid causing an over-g when airspeed is greater than corner velocity (reference Figure 5.1).

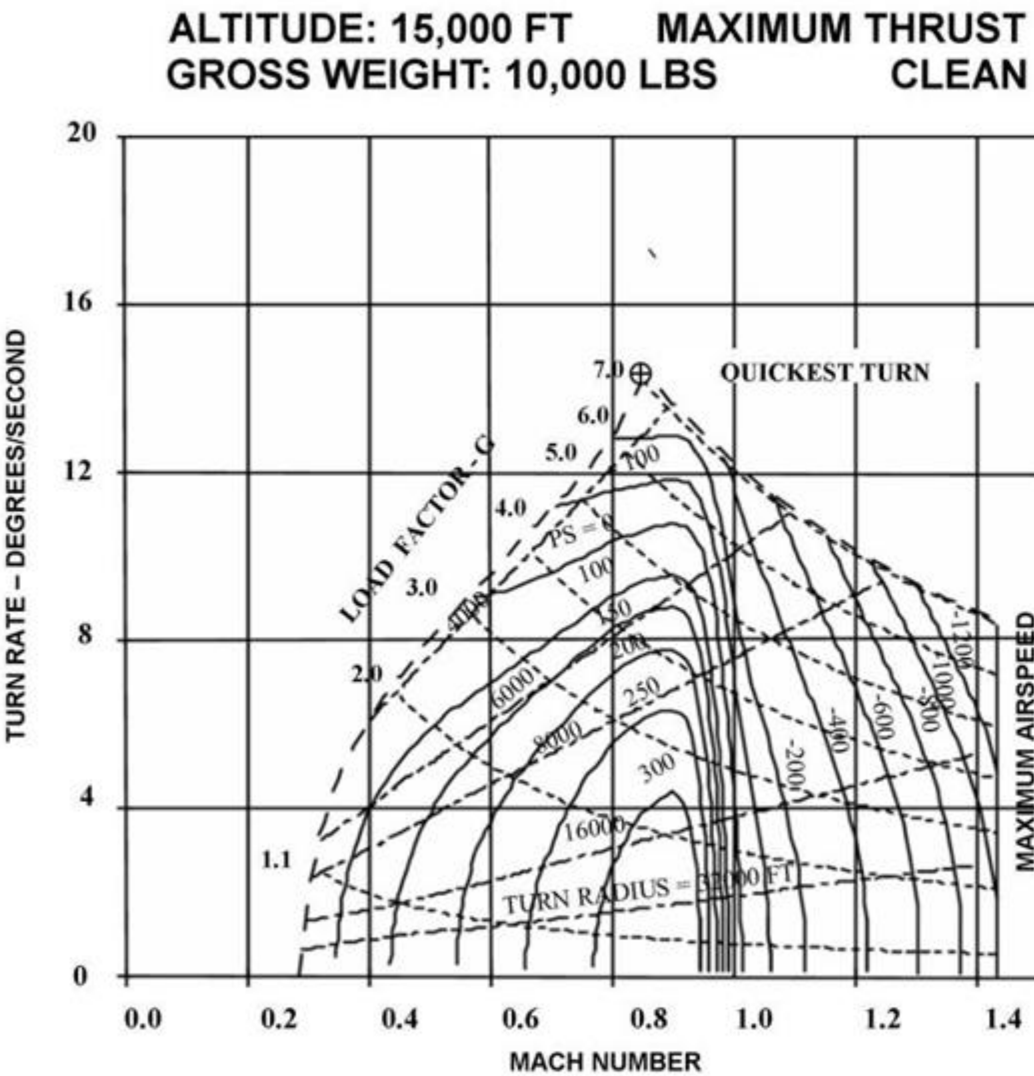
5.3.5. Gaining Energy. The best way to gain a large amount of energy is a wings-level climb at or near the tech order climb schedule. Gaining energy is enhanced with light AOA or G loading and maximization of excess thrust with the aircraft lift vector pointed vertically up. MAX power could be used (within engine envelope restrictions) but is rarely the most fuel-efficient way to gain energy. Many pilots will use MIL power for most energy-gaining maneuvers. Do not hesitate to use MAX power for small, quick changes in airspeed or when the aircraft is already at a high CAS.

5.3.6. Maneuverability Diagrams:

5.3.6.1. An energy maneuverability (EM) diagram (**Figure 5.1**) plots airspeed or Mach against turn rate with lines of constant G-load, turn radius, and specific excess power (PS or “P- sub-S”) contours represent the performance capabilities of an aircraft for a given set of flight conditions, including altitude, configuration, weight, and power setting.

5.3.6.2. The lines on the diagram represent the aircraft's ability to change altitude, airspeed, and direction of flight by considering lift, aerodynamic drag, structural limits, thrust, weight, and velocity.

Figure 5.1. Energy Maneuverability Diagram.



5.4. Flight Control Characteristics:

5.4.1. Rudder. Effective use of the rudder is important throughout the T-38 flight regime and should not be ignored. Generally, the rudder is more effective at high AOA and less effective at low AOA.

5.4.2. Ailerons. Ailerons are most effective at low AOA and become less effective as AOA increases. Be cautious of aileron sensitivity and rapid aircraft roll rates, especially at low AOA. At high speeds and low AOA, large stick deflections may exceed aircraft limits.

5.4.3. Speed Brake. The speed brake has minimal effect below 250 KCAS. Little or no pitch change occurs when activating the speed brake below 250 KCAS. At airspeeds above 250 KCAS, speed brake extension causes a slight pitch up, and retraction causes a slight pitch down. The pitch changes are not abrupt; you can easily overcome them with smooth control inputs.

5.4.4. Trim Techniques. Proper trim technique is essential for smooth and precise aircraft control during all phases of flight. The basic rule for proper trim is simple: Establish and hold a desired attitude by applying control stick pressure, then trim to relieve the pressure. Normally, large trim changes are not necessary. Use “clicks” of trim when trimming the aircraft.

5.5. Pilot-Induced Oscillation (PIO). Over-controlling pitch corrections can result in a PIO, especially at high airspeeds. During a PIO, your control inputs lag behind the aerodynamic forces acting on the aircraft, and flight deviations will actually increase as you try to correct them. To avoid this potentially dangerous situation, make smooth control inputs and, if encountered, freeze the stick slightly aft of neutral until oscillations stop.

5.6. G-Awareness Exercise:

5.6.1. Perform the G-awareness exercise to warm up or assess your personal G-tolerance, and practice the timing and execution of your anti-G straining maneuver (AGSM). Also check your anti-G suit and the aircraft’s system for proper operation. Use MIL power and 420±20 KCAS to provide adequate airspeed to sustain the appropriate Gs without losing excessive altitude. Set the FPM approximately 8 to 10 degrees nose-low to maintain 4-4.5 Gs and approximately 18-20 degrees nose-low to maintain 5-5.5 Gs.

5.6.2. When executing high-G maneuvers while looking over your shoulder, you will find the AGSM more difficult to do properly and more tiring. Increased emphasis on the AGSM is necessary during high-G maneuvers.

Section 5B—Aircraft Handling

5.7. Airframe Buffet Levels. As a baseline for common reference, this manual will use the following terms for airframe buffet levels, described in order of increasing AOA:

5.7.1. Light Tickle. Light tickle is the first consistent appearance of high frequency, low amplitude vibration on the airframe due to AOA. The lower the airspeed the higher the AOA at which this occurs - typically at about 0.55 AOA during clean, 1G flight at speeds below 300 KCAS, to about 0.4 AOA at 400 knots

5.7.2. Light Buffet. Light buffet is a consistent, light airframe vibration that normally occurs at 0.6 AOA (green donut).

5.7.3. Moderate Buffet. Moderate buffet is a consistent, moderate airframe vibration that normally occurs from approximately 0.7 AOA to the definite increase in buffet intensity, just short of wing rock.

5.7.4. Definite Increase in Buffet Intensity (DIBI). The definite increase in buffet intensity is the point where the frequency of airframe vibrations becomes inconsistent, irregular and slower with the amplitude often increasing beyond the moderate buffet level. This typically occurs above 0.8 AOA—usually closer to 0.8 AOA with the flaps up, and potentially above 0.9 AOA with the flaps at 60 or 100 percent. In some aircraft, the definite increase in buffet intensity may not be noticeable prior to entering wing rock.

5.7.5. Heavy Buffet. Heavy buffet is the buffet from AOA higher than the definite increase in buffet intensity to the point where the stick is at the aft stop.

5.7.6. Wing Rock. Wing rock normally occurs just prior to a fully developed stall and includes exaggerated, alternating drops of each wing.

5.8. Aircraft Handling Characteristics (AHC). The following exercises display the handling characteristics and qualities of high-performance, swept-wing aircraft. They are exercises, not precise maneuvers. Developing a feel for handling characteristics is more important than achieving specific parameters. When observing or flying these exercises, note when the flight control surfaces are most effective and how airspeed and AOA changes affect the aircraft handling characteristics.

5.8.1. Variations in aircraft rigging, coupled with flight control inputs, may cause as severe wing rock or other abnormal rolling tendencies (e.g., while executing AHC maneuvers, bank angle exceeds 90 degrees or stabilizes over 60 degrees). If aircrews suspect rolling tendency is abnormal, discontinue the maneuver, recover the aircraft, and consider conducting a controllability check if necessary. Upon approach and landing, fly the most conservative approach using a normal configuration to a full stop landing. Write the aircraft up in the AF Form 781.

5.9. Full Aft-Stick Stall:

5.9.1. This stall demonstrates aircraft characteristics throughout the stall regime and shows the importance and effectiveness of relaxing backstick pressure during a stall recovery. In this stall, the stall progresses far beyond the situation encountered in normal flight or approach-to-stall training.

5.9.2. This exercise demonstrates the aircraft's stability in a stall, the ability to recover from any stall simply by relaxing backstick pressure, and the excessive altitude lost when recovering from a stall without using increased power. Always consider increasing power to minimize altitude loss in an inadvertent stall recovery.

5.9.3. ***Begin in level flight below FL 200 with power set at 80 percent rpm minimum.***

5.9.4. As airspeed decreases, hold the pitch constant by smoothly and steadily pulling the stick straight back to the stop with no aileron inputs. Mild wing rock is normal as AOA increases.

5.9.5. As you approach full aft stick, wing rock will occur and a high sink rate will develop. Keep the ailerons neutral and the stick full aft against the stop. Note the buffet and AOA progression—especially the definite increase in buffet intensity in excess of 0.8 AOA, full stall around 1.0 AOA, and fully-developed stall at 1.1 AOA. In the fully developed stall, pitch stabilizes slightly nose-low, airspeed settles around 140 KCAS, AOA reaches the stop at 1.1, and vertical velocity increases to a 6,000 fpm descent.

5.9.6. After the stall is fully developed, recover by leaving the power alone and relaxing backstick pressure. As the airspeed increases, reapply backstick pressure and add power as required. Recover to a level-flight attitude. Use caution not to overspeed the gear and (or) flaps during the recovery.

5.9.7. Slight variations in aircraft rigging, coupled with flight control inputs, may cause severe wing rock. ***If bank exceeds 90 degrees or stabilizes over 60 degrees, discontinue the exercise and recover the aircraft from the stall.*** If the aircraft displays abnormal rolling tendencies, follow guidance in **para 5.8.1**. Write the aircraft up in the AF Form 781 following completion of the mission. Watch for potential gear or flap overspeed if configured.

5.10. Simulated Trim Failure:

5.10.1. Simulated inoperative trim will familiarize you with the stick pressures required when the stabilator trim fails. If you release pressure on the control stick after the stabilator trim has failed, the stick will move to the trimmed position and the aircraft will aerodynamically search for the trimmed airspeed.

5.10.2. Perform this exercise below FL 200. Begin with airspeed above 300 KCAS and trim the aircraft for level flight. Without re-trimming, slow the aircraft to normal final approach airspeed. As the airspeed decreases below 240 KCAS, configure the aircraft with gear and full flaps. Note the increase in stick forces as the airspeed decreases and the configuration changes.

5.10.3. After experiencing the pressures at final approach airspeed, re-trim the aircraft to relieve the stick pressures. Without trimming the aircraft, execute a simulated go-around, retracting the gear and flaps, and accelerate to an airspeed above 300 KCAS. Note the increasing stick pressures associated with the configuration and airspeed changes. Turn the aircraft and note how increased bank helps maintain altitude and provide relief from the constant forward stick pressures.

5.10.4. After completing the exercise, and before any other maneuvering, re-trim the aircraft. If you encounter approach-to-stall indications at any time, simultaneously execute stall recovery procedures and re-trim the aircraft to eliminate unwanted stick pressures.

5.11. Rudder Effectiveness at Slow Speed:

5.11.1. This exercise demonstrates flight characteristics during the landing phase and the measurable delay between the time a rudder input is applied and the time it takes effect on the aircraft. With the aircraft configured with gear down and flaps at any setting (for example, full, 60 percent, or no-flap), apply varied amounts of rudder inputs for varying lengths of time and examine the roll characteristics.

5.11.2. First, configure the aircraft and achieve a level attitude with approach-to-stall parameters (approximately 0.8 to 0.85 AOA) simulating a level final turn traffic pattern stall.

5.11.3. Then, as quickly as possible, apply full top rudder and wait until the aircraft begins to react. At that time, neutralize the rudders and note how the aircraft will over-correct to approximately 45 degrees of bank in the opposite direction. Maintain neutral aileron inputs to isolate rudder characteristics. Note the effectiveness of the rudder with full deflection and the delay between rudder input and aircraft reaction.

5.11.4. Using the same setup up as in **paragraph 5.11.2** now apply full top rudder and immediately take out the input before the aircraft begins to react. The aircraft will tend to right itself close to level flight. **Note:** When applying near-full rudder deflection, it is important to return the rudder to neutral quickly to avoid excessive bank in the direction of rudder deflection.

5.12. Aileron Effectiveness Exercise. This exercise demonstrates the increased effectiveness of the ailerons at low G-loads and AOA. With the power set between 85 percent rpm and MIL power, roll the aircraft at various G loads and AOA using only the ailerons. One technique is to establish a 20-degree nose-high pitch attitude, set the power at approximately 90 percent rpm, and allow the airspeed to decrease to 150 KCAS. At 150 KCAS, increase backstick pressure to attain moderate buffet. Maintain this buffet, and roll the aircraft using the ailerons. Note the roll rate. Next, while maintaining the moderate buffet and the same aileron deflection, smoothly unload the aircraft to approximately 0.5 G. Note how the roll rate increases. Ailerons become more effective as the angle of attack decreases, regardless of airspeed. Relaxing backstick pressure will reduce angle of attack, thereby increasing aileron effectiveness.

5.13. Turn Reversals:

5.13.1. This exercise demonstrates the tactical usefulness of turning the aircraft with ailerons alone under a low AOA condition vice turning the aircraft with the rudder alone under higher AOA conditions. The order in which you accomplish the turns is not important, but accomplish both turns between 350 and 400 KCAS with a minimum of MIL power.

5.13.2. For both turns, roll the aircraft into approximately 90 degrees of bank and increase the backstick pressure to achieve approximately 4Gs. be careful not to exceed the asymmetrical G limits of the aircraft during this exercise.

5.13.3. After establishing approximately 4Gs, accomplish one reversal by unloading the aircraft and using only the ailerons to quickly reverse the lift vector, and establish a 4G turn in the opposite direction. Note how quickly you accomplish the turn and how little airspeed you lose during the reversal.

5.13.4. After establishing approximately 4Gs again, accomplish one reversal by using only the rudder. Altitude and energy will determine whether you use the top or bottom rudder. If using the top rudder, note the airspeed bleed off during the reversal. If using the bottom rudder, note the altitude loss. In both cases, the reversal will be slower than the one accomplished with ailerons and low AOA.

5.14. Accelerated Stall:

5.14.1. This stall demonstrates the effect that increasing AOA has on turning performance and airspeed loss. For this exercise, use approximately 300 KCAS to decrease the necessary G loading and the potential to exceed G limits and to reduce the time required to reach the increased buffet or mild wing rock.

5.14.2. Begin by entering a 2 to 3 G turn with MIL power and approximately 300 KCAS. Increase the bank and backstick pressure as required to achieve the light buffet in a level turn. Note the turn rate and “light tickle.” This is optimum turn performance for the T-38.

5.14.3. Then rapidly increase the bank and backstick pressure to achieve either increased buffet or mild wing rock. Note that the turn rate will increase initially, but as the AOA continues to increase, the turn rate will decrease and the airspeed loss will increase. This is also very evident during HUD VTR review during debrief.

5.14.4. Without reference to any cockpit indications, you should be able to note when the AOA has increased beyond a useful point. Next, relax the backstick pressure to decrease the AOA and continue the turn with a light buffet.

5.15. Pitchback.

5.15.1. A pitchback is similar to an Immelmann except it begins with a bank angle greater than 0 degrees (but less than 90 degrees) and uses less altitude. The objective is to minimize turn time while maneuvering using visual references. Concentrate on the simple mechanics of flying a pitchback without regard to energy level.

5.15.2. Enter the pitchback from level flight with 450 to 500 KCAS. With the power at MIL, roll to the desired bank angle, neutralize the ailerons, and apply backstick pressure to attain 4 to 5 Gs. Maintain 4 to 5 Gs or a light buffet as airspeed decreases and a straight-nose track through approximately 180 degrees of turn.

5.16. Sliceback. A sliceback is similar to a split-S except it begins with a bank angle greater than 90 degrees (but less than 180 degrees) and uses less altitude. The objective is to reverse direction of travel using potential energy (altitude) to maintain or gain airspeed. Enter the sliceback with 200 to 300 KCAS. With the power stabilized at MIL, roll to the desired bank angle, neutralize the ailerons, and apply backstick pressure to attain the light buffet. Maintain the light buffet and a straight-nose track through approximately 180 degrees of turn. The higher the entry airspeed the more you need to watch the Gs at the bottom, and use caution for rolling inputs which could cause an asymmetrical over-G.

5.17. Pitch-to-Slice Exercise. Start the exercise by executing a pitchback at 450 to 500 KCAS at MIL power and a bank angle greater than 0 degrees (but less than 90 degrees). Turn your head to look straight back toward the tip of the vertical tail; pick a point above you (a cloud if available; if not available, pick an imaginary point); and execute a 4 to 5G straight pull. As you pull through the horizon (at greater than 90 degrees of bank), continue with a sliceback with a straight pull at the light buffet. Continue to look at the vertical tail and pick a point on the ground to pull to. The exercise is complete when you return to level flight in a bank greater than 0 degrees (but less than 90 degrees). This maneuver teaches a reliance on visual lookout and clearing while sensing bank and pitch by looking outside the cockpit as well as flying the aircraft by feel for buffet and G.

5.18. Low-Speed Stability Exercise:

5.18.1. Commonly referred to as the “stab ex,” or “stab demo,” this exercise demonstrates the stability potential of high-performance aircraft at extremely low airspeeds. Establish a 60-degree nose-high pitch attitude, and set power at a minimum of 85 percent rpm. Use the power setting to control the airspeed bleed off and altitude gain.

5.18.2. As the airspeed decreases through 170 KCAS, smoothly unload the aircraft. With the aircraft unloaded, note how far the airspeed decreases without stall indications or loss of control. As the aircraft passes level-flight attitude, apply full backstick pressure and attempt to maintain level flight. Note the initial complete ineffectiveness of back stick pressure followed shortly by onset of stall indications.

5.18.3. Once again, unload the aircraft and note how stall indications cease. Maintain positive G until reaching an airspeed between 175 and 200 KCAS; then recover the aircraft to level flight. Do not move the throttles until greater than 175 KCAS unless required for safety. Maintain oil system limitations throughout this maneuver. If the airspeed decreases below stabilator effectiveness, the aircraft will immediately stall and may enter post-stall gyrations.

5.18.4. Because the coefficient of lift for a symmetrical airfoil is always zero at 0 G, the wing cannot exceed the critical AOA. Therefore, when faced with a nose-high, low-airspeed, unusual attitude, unloading the aircraft will ensure aircraft control as long as possible.

5.19. Slow Flight. Slow flight demonstrates the low-speed handling characteristics of the T-38 and emphasizes the importance of smooth control inputs during this flight condition. After configuring, slow to 10 knots below computed final approach airspeed. Normally accomplish slow flight in level flight; however, a slight descent may be required. The AOA indexer lights will show a slow indication (approximately 0.7 AOA). Perform coordinated turns, using various angles of bank. Note how the AOA changes with fore and aft stick movements, throttle movements, and changes in bank.

5.20. Slow Flight Recovery Demonstration:

5.20.1. This demonstration shows the effects of various flap settings on aircraft acceleration at low airspeeds. It is particularly applicable to aircraft handling during the flare and (or) go-around.

5.20.2. In level flight with gear down, full flaps, slow flight airspeed, and a constant power setting, retract the flaps to 60 percent. Note how the aircraft accelerates and the AOA decreases. Reestablish full flaps and slow flight airspeed. When stabilized in level flight and maintaining a constant power setting, fully retract the flaps. Note that, as the flaps pass through 60 percent, the aircraft starts to accelerate and the AOA decreases. As the flaps continue toward the full-up position, the buffet increases, airspeed decreases, and aircraft approaches a stall.

5.21. Supersonic Flight:

5.21.1. Due to its unique nature, this type of flight requires additional planning considerations. Prior to the preflight briefing, check the forecast temperature at the supersonic run altitude, and review engine operating limitations, associated emergency procedures, the afterburner climb schedule, and any local coordination requirements and restrictions. During flight, use actual outside air temperature (OAT) displayed on the MFD DATA display page to verify your minimum Mach number.

5.21.2. The single significant consequence of going supersonic is wave drag. This increase in total drag starts slightly above critical Mach (noticeable by .95 Mach). The transition from subsonic to supersonic flight occurs with little apparent aircraft reaction. At Mach 1, a detached shock wave forms in front of the pitot tube causing the altimeter and vertical velocity indications to jump. Because the engines are operating in an area of increased stall susceptibility, use caution when terminating the supersonic run. Smoothly retard one throttle out of afterburner, and ensure proper engine operation before retarding the second throttle out of afterburner. Also, do not allow the airspeed to decrease below the IMN recommended in the flight manual. Finally, use caution to prevent exceeding Mach 1 during the descent below FL 300.

Section 5C—Traffic Pattern Stalls and Approach-to-Stall Training

5.22. Purpose:

5.22.1. The Air Force has lost many lives and aircraft due to traffic pattern accidents. In the T-38, it is particularly easy to put yourself into an unrecoverable stall or sink rate situation before the indicators get your attention.

5.22.2. Stall training in the MOA develops a number of critical skills that can prevent catastrophe in the traffic pattern. Stall training keys on the important areas of recognition and recovery. Approach-to- stall training is not a precise maneuver. It is designed to teach stall recognition and stall recovery. Although approach-to-stall training simulates conditions that may arise in the traffic pattern, this training is applicable to all phases of a T-38 mission. Practice with 0 percent, 60 percent or full flaps. Note the less defined onset of the increased buffet at lower flap settings. There will be a greater possibility for a secondary stall during no-flap approach-to-stall training.

5.22.3. It is important that you are able to recognize all approach-to-stall characteristics. Individual aircraft can have slightly different handling characteristics near the approach-to-stall region. The definite increase in buffet intensity can occur slightly before or after the aural, HUD, or MFD stall warnings (triggered at and above 0.80 AOA). In order to gain an understanding of the feel of the aircraft at the definite increase in buffet intensity, the AC/instructor can brief to ignore the aural, HUD, or MFD stall warnings during MOA stall training. Another reason for needing to understand the feel of the aircraft at the definite increase in buffet intensity is so that, during the stall recovery, you are able to maximize aircraft performance by flying just shy of the definite increase in buffet intensity. It is not abnormal during a wings-level, MAX power stall recovery to be at or above 0.80 AOA and have the aural, HUD, or MFD stall warnings activated.

5.23. Turning Approach-to-Stall Exercise. Establish the landing configuration, ***at or below FL200 and set power at 80 percent rpm minimum no later than deceleration through 200 KCAS***, and fly a simulated final turn with an intentional error. Possible errors include a level final turn, a diving final turn, or an overshooting final turn. For the level final turn, maintain a fairly constant bank angle and allow the airspeed to decrease until reaching the definite increase in buffet intensity, or the aural, HUD, or MFD stall warnings. For errors other than the level final turn, progressively increase the bank and backstick pressure. For any of the above examples, as you detect a definite increase in buffet intensity, the aural, HUD, or MFD stall warnings, however briefed by the AC/instructor, execute the stall recovery.

5.23.1. Level Final Turn Setup/Characteristics. As a technique, after establishing a normal final turn (approximately 45 degrees of bank and 5 to 7 degrees nose low). Roll out to approximately 30 degrees of bank and raise the nose 4 to 5 degrees while pulling the power no lower than 80 percent rpm. The characteristics will be a slower stall onset rate and slower rate of recovery. This setup is a useful training aid identifying the different stall characteristics listed in **section 5.7**.

5.23.2. Diving Final Turn/Overshooting Final Setup/Characteristics. As a technique, after establishing a normal final turn, continue to increase bank to 60 degrees of bank while increasing back stick pressure and pulling the power no lower than 80 percent rpm minimum. The characteristics will be a quicker stall onset rate and proportionally quicker rate of recovery.

5.24. Landing Attitude Approach-to-Stall Exercise. Establish the landing configuration, set the power ***(80 percent rpm minimum at or below FL200)***, attain a landing attitude, and allow the airspeed to decrease. A common technique is to maintain level to approximately 1,000 fpm vertical velocity. As you detect a definite increase in buffet intensity, or the aural, HUD, or MFD stall warnings, however briefed by the AC/instructor, execute the stall recovery. Use greater finesse to recover due to the slow stall speed in a wings-level situation.

5.25. Stall and Approach-to-Stall Recovery Completion. Recovery is complete when the descent is stopped, a positive controlled climb is established (altimeter and vertical velocity reversed), and the aircraft has sufficient airspeed for continued flight.

Section 5D—Abnormal Flight Recoveries

5.26. Purpose. You may find yourself in a flight attitude where loss of aircraft control is imminent unless you initiate a proper recovery. Although the recoveries indicated in paragraphs 5.28 and 5.29 may appear simple, the events leading up to them can result in confusion or disorientation that would severely hamper your recovery efforts.

5.27. Abnormal Recovery Setup Guidelines:

5.27.1. During any abnormal flight recovery setup, IP vigilance is paramount. Do not compromise safe flight during IP demonstration or student performance of recovery training. In all situations where transfer of aircraft control is involved, it will be accomplished IAW AFI 11-2T-38, Volume 3.

5.27.2. Abnormal flight recovery training should be thought of in the following three phases of proficiency: (**Note:** These phases are not necessarily linked to a particular block of training, but are linked to the student's flying abilities and situational awareness [SA].)

5.27.2.1. The IP demonstrates and flies the complete setup and recovery while delivering appropriate verbal instruction. Once the student has seen the recovery demonstrated and has a basic grasp of why the recovery training is performed, the IP begins setting up recovery situations for the student and talking him or her through the recovery procedures.

5.27.2.2. When the student shows proficiency in the recovery procedures, the IP begins setting up observable situations requiring an abnormal flight recovery. When the setup is completely developed, the IP transfers control of the aircraft to the student, using the verbal command, "You have the aircraft— recover." The student takes the aircraft and recovers from the abnormal attitude.

5.27.2.3. Once the student has seen all the different types of setups and can confidently and proficiently recover from various situations, the IP sets up abnormal flight recoveries randomly throughout the area profile. Once the setup is complete, the IP directs the student to take the aircraft with "You have the aircraft." The student takes the aircraft with proper transfer procedures and recovers in the appropriate manner.

5.27.3. Once a student learns the correct stick and throttle inputs, it is imperative to build his or her judgment and ability to recognize abnormal flight and the need to accomplish an abnormal flight recovery. The IP should concentrate primarily on developing the student's SA.

5.28. Nose-High Recovery:

5.28.1. Use a nose-high recovery to return to level flight following an unrecognizable or potentially unsafe nose-high attitude. Choose a recovery technique commensurate with the severity of the nose-high attitude. Make any required power increases smoothly to prevent engine compressor stalls and flameouts.

5.28.2. Some instances, such as moderate pitch attitudes or near wings-level attitudes, may simply require relaxing back stick pressure and maintaining slight G forces while recovering to level flight. However, extreme pitch attitudes may require rolling toward the nearest horizon and pulling the nose down to a level-flight attitude. In addition, extremely low airspeeds may require an unloaded recovery resembling the low-speed stability exercise.

5.28.3. With all of these techniques, if airspeed is sufficient as the nose approaches the horizon, rollout and return to level flight. If airspeed is insufficient to comfortably maintain level flight as the nose passes the horizon, delay the rollout until the nose is definitely below the horizon and continue to accelerate in a slight descent until you can return to level flight.

5.29. Nose-Low Recovery:

5.29.1. Use a nose-low recovery to return to level flight or a slight climb following an unrecognizable or potentially unsafe nose-low attitude in the minimum turn radius. The minimum turn radius is achieved by maintaining the aircraft at the aerodynamic or G limit between approximately 250 knots and corner velocity (approximately 400 knots). To achieve this, quickly roll the aircraft to the nearest horizon and apply backstick pressure to achieve the moderate buffet or desired recovery G (whichever comes first). Normally, 4 to 5 Gs are sufficient for an expeditious recovery in the MOA. In a nose-low recovery situation where proximity to the ground is a concern, do not hesitate to pull to the aerodynamic/G limit of the aircraft.

5.29.2. Adjust power and (or) speed brakes to maintain the airspeed between approximately 250 and 400 knots. The “feel” of the aircraft may be used to help analyze airspeed. If the aircraft is at the desired G limit and no buffet is felt, reduce the airspeed to minimize the turn radius. If a moderate buffet is felt prior to reaching the desired G, set the power to at least MIL until the buffet begins to go away at the desired recovery G.

Section 5E—Aerobatic Maneuvers

5.30. Purpose. Aerobatic maneuvers exploit the maneuvering envelope of the aircraft, develop skills and confidence required to employ combat aircraft, improve energy management skills, and build three- dimensional SA. As transition maneuvers, aerobatics require a disciplined composite cross-check, using references inside and outside the cockpit. For example, airspeed, altitude, and G loading must be verified inside the cockpit; clearing and ground track control must be accomplished using outside references; and attitude and area orientation usually require both inside and outside references. When available, use outside references to enhance clearing and maneuver precision.

5.31. Aerodynamic Parameters. The mechanics of performing aerobatic maneuvers in the T-38 are essentially the same as in previous training, but differences exist in power settings, airspeeds, G loadings, required airspace, and handling characteristics. Entry parameters for each maneuver are summarized in **Table 5.1**. Fly all aerobatic maneuvers using the range of airspeeds and power settings within specified parameters. Remain in visual meteorological conditions (VMC) during aerobatic maneuvering.

Table 5.1. Summary of Entry Parameters for Aerobatics.

ITEM	A **Maneuver**	B **Airspeed**	C **Power Setting**
1	Lazy Eight	350 to 400 KCAS	95 percent RPM
2	Barrel Roll	375 to 400 KCAS	95 percent RPM
3	Loop	500 KCAS	MIL power
4	Split-S	200 KCAS	MIL power
5	Immelmann	500 KCAS	MIL power
6	Cuban Eight		
7	Cloverleaf	450 KCAS	MIL power

5.32. Factors Affecting Aerobatic Maneuvers in the Vertical. Several factors work together to affect the altitude required to complete over-the-top or split-S type maneuvers. They are entry airspeed, power setting, aircraft weight, and pilot technique. The following general rules of thumb apply when flying aerobatic maneuvers:

5.32.1. Turn radius depends on G loading and airspeed.

5.32.2. Holding other parameters constant, higher G loading reduces the altitude required to complete the maneuver, while higher airspeed increases the altitude required.

5.32.3. Higher power settings improve turn performance at low airspeeds. Thrust offsets the higher induced drag present under higher AOA, thus preserving airspeed (and, therefore, G available). In contrast, a lower power setting combined with high-induced drag degrades the ability to acquire or sustain G available. Combinations of these variables can cause up to a 2,000 to 3,000 feet difference in altitude required for an over-the-top maneuver.

5.32.4. As a guide, plan for at least 10,000 feet when accomplishing aerobatics in the vertical plane (over-the-top and split-S-type maneuvers).

5.33. Energy and Airspace Requirements:

5.33.1. **Table 5.2** shows distances from the start of the actual maneuver to completion of the maneuver. Theses distances do not include any airspace used in setting up the maneuver or any airspace used to perform the flyout following the maneuver.

Table 5.2. Airspace Requirements.

ITEM	**A** **Maneuver**	**B** **Lateral Distance Required**	**C** **Altitude Required**
1	**Lazy Eight**	**2 nm forward; 6 nm in direction of turns**	**4,000 to 6,000 feet above**
2	**Barrel Roll**	**3 nm forward**	**4,000 to 8,000 feet above**
3	**Loop**	**1 to 2 nm forward**	**8,000 to 10,000 feet above**
4	**Split S**	**1 nm forward; 1 nm behind**	**7,000 to 10,000 feet below**
5	**Immelmann**	**1 nm forward**	**8,000 to 10,000 feet above**
6	**Cuban Eight**	**1 nm forward; 2 nm behind**	

7	**Cloverleaf**	**3 nm forward; 2 nm in direction of first turn; 3 nm opposite direction of first turn**	

5.33.2. Entering an over-the-top maneuver involves flying the aircraft to a point where entry parameters can be reached with sufficient airspace above or below required to complete the maneuver. First of all, the overall energy level must be assessed and adjusted, if required, to meet entry parameters. Techniques for making this assessment were discussed in paragraph

5.33.3. Once the desired energy level has been attained, the aircraft must be flown to an altitude that permits starting the maneuver. If this involves a descent, one technique is to lead the pullout by 10 knots and (or) 500 feet for each 10-degree nose-low (for example, for 50-degrees nose-low, lead the pullout by approximately 50 knots and (or) 2,500 feet). If the over-the-top maneuver involves achieving the starting altitude at the completion of the maneuver, ensure that the altitude for starting the maneuver allows for a buffer below the starting altitude so that airspace limits are not violated. (Don't start at the airspace floor with no room below for error).

5.33.4. Energy can be affected by how the maneuver is flown. Low energy can be affected in one of two ways. First, if airspeed is relatively high, but altitude is low, fly the first portion of the over-the-top maneuver using 4 to 4.5 Gs (vertical airspace permitting). Then use the light tickle and "float" the upper portion of the pull. This technique may offer the opportunity to gain energy during the loop. If airspeed is low (regardless of altitude), pull closer to 5 Gs initially to make it over the top with greater than the minimum over-the-top airspeed of 150 KCAS. This should allow you to complete the loop; however, this technique may result in an overall energy loss. High energy can easily be reduced by increasing induced drag (higher AOA and G loading) during the maneuver. Additionally, over-the-top maneuvers will lose approximately 500 feet of energy for each maneuver (loop) or leaf (Cuban Eight or cloverleaf).

5.34. Aileron Roll. Aileron rolls can be performed at any airspeed and at various pitch attitudes. The T-38 is capable of an extremely high roll rate, so relax control pressure during the last part of the roll to prevent overshooting the wings-level attitude. Stay smooth, and don't attempt to keep the nose on a point.

5.35. Lazy Eight:

5.35.1. Entry parameters are 350 to 400 KCAS using 95 percent rpm.

5.35.2. From straight-and-level flight, pick a point 90 degrees off the nose (in the direction of the first turn). Start a smooth, climbing turn in that direction so the nose describes an arc above the horizon, reaching the maximum pitch attitude at approximately 45 degrees of turn.

5.35.3. One technique is to drag the landing gear handle (left turn) or NAV backup control panel (right turn) across the horizon. This should equate to approximately 20 degrees to 30 degrees nose-high. The nose should then start back down, passing through the horizon after 90 degrees of turn with approximately 90 degrees of bank at approximately 200 knots. As the nose passes through the horizon, begin a smooth, gradual rollout and pull-up, planning to reach the maximum nose-down pitch attitude after approximately 135 degrees of turn. At this point, the canopy bow should be on or near the horizon (approximately 20 degrees to 30 degrees nose-low).

5.35.4. Complete the first half of the maneuver after approximately 180 degrees of turn in a wings- level flight attitude with the entry airspeed. Enter the second half of the maneuver by turning in the opposite direction. Complete the lazy eight with the aircraft headed in the original direction at entry airspeed.

5.35.5. The emphasis is on flying a smooth, symmetrical maneuver with constantly changing parameters.

5.35.6. A lazy eight will require approximately 2 NM forward, 6 NM to your right or left—in the direction of the turns—and 4,000 to 6,000 feet above.

5.36. Barrel Roll:

5.36.1. Entry parameters are 375 to 400 KCAS using approximately 95 percent rpm.

5.36.2. The barrel roll is a coordinated roll in any direction in which the nose of the aircraft describes a circle around a point. Choose a point on or slightly above the horizon and maneuver the aircraft to attain entry parameters in a wings-level attitude with the aircraft 30 to 45 degrees to the side of the selected point. Begin a rolling pull in the desired direction and use smooth control inputs to maintain a circular flightpath around the reference point. You should be (1) in 90 degrees of bank directly above the selected reference point, (2) in a wings-level inverted attitude when passing abeam the reference point at 180 degrees of roll, (3) in 90 degrees of bank directly below the selected reference point, and (4) in a wings-level upright attitude when completing the maneuver. The pitch at (1) and (2) should be the same amount of degrees above and below the reference point.

5.36.3. Another technique is to begin the maneuver by choosing a desired roll axis from which to fly the barrel. Offset this roll axis the number of degrees that defines the size of the roll (normally 30 to 45 degrees). Pick a point on the horizon twice the number of degrees of the offset in the desired direction of the roll. For example, if selecting a 45-degree offset, pick a point 90 degrees off the nose.

5.36.4. Begin a coordinated roll and pull to fly the nose of the aircraft to be inverted at the point. Continue the coordinated roll or pull to fly the aircraft back to the original offset heading. You should be at 90 degrees of bank as the nose of the aircraft passes the original roll axis (both on the first and second half of the roll), and the degrees nose-high and -low at these points are defined by the number of degrees of the original offset. The ending airspeed should be approximately the same as the entry airspeed for a symmetrically flown maneuver, but symmetry is more important than finishing at entry airspeed.

5.36.5. Maintain positive G loading throughout the roll. To gain energy, use higher power settings or a lighter G loading.

5.36.6. A barrel roll will require a forward distance of approximately 3 NM and 4,000 to 8,000 feet above.

5.37. Loop:

5.37.1. Entry parameters are 500 KCAS using MIL power.

5.37.2. Begin the loop with entry airspeed and approximately 10,000 feet of altitude above you. Smoothly apply backstick pressure until reaching approximately 4.5 to 5 Gs in a straight pull. Continue to increase backstick pressure to maintain the light buffet “green donut.”

Ensure wings are level when passing through the horizon inverted. Maintain backstick pressure to maintain the light buffet to light tickle as Gs build to approximately 4 to 5 on the bottom side of the loop. Finish the maneuver in level flight at entry parameters, unless flowing immediately into another maneuver.

5.37.3. A loop will require approximately 1 to 2 NM forward and 8,000 to 10,000 feet above you from the start of the pull until maneuver completion. This does not include airspace used to set the maneuver up or post-loop maneuvering. Expect to lose 500 feet of energy per loop.

5.38. Split-S:

5.38.1. Entry parameters are 200 KCAS using MIL power.

5.38.2. The split-S is essentially the last half of a loop. Enter the split-S from a slight climb to ensure completion of the roll to the wings-level inverted attitude before the nose reaches the horizon. One technique is to begin the maneuver with 230 KCAS, pull 10 degrees nose high, unload and roll to a wings level inverted position (front cockpit reference—canopy bow on the horizon). Once inverted, neutralize the ailerons and increase backstick pressure to attain light buffet in a straight pull. Maintain the light buffet until reaching 4 to 5 Gs or the completion of the maneuver.

5.38.3. The maneuver is complete when you are wings level approximately 180 degrees from entry heading. There is no exit airspeed, although exits as high as 380 to 440 KCAS are typical. If the maneuver is intended to blend into another maneuver, the pull may be modified to attain desired follow- on entry airspeed. A split-S requires approximately 1 NM forward, 1 NM behind, and 7,000 to 10,000 feet below.

5.39. Immelmann:

5.39.1. Entry parameters are 500 KCAS using MIL power.

5.39.2. The Immelmann resembles the first half of a loop followed by a half roll at the top. Begin the Immelmann by using the same mechanics as a loop. Just prior to reaching the inverted, level-flight attitude (front cockpit reference—canopy bow on the horizon), relax backstick pressure and execute a half roll in either direction. Complete the maneuver in level flight 180 degrees from the original heading.

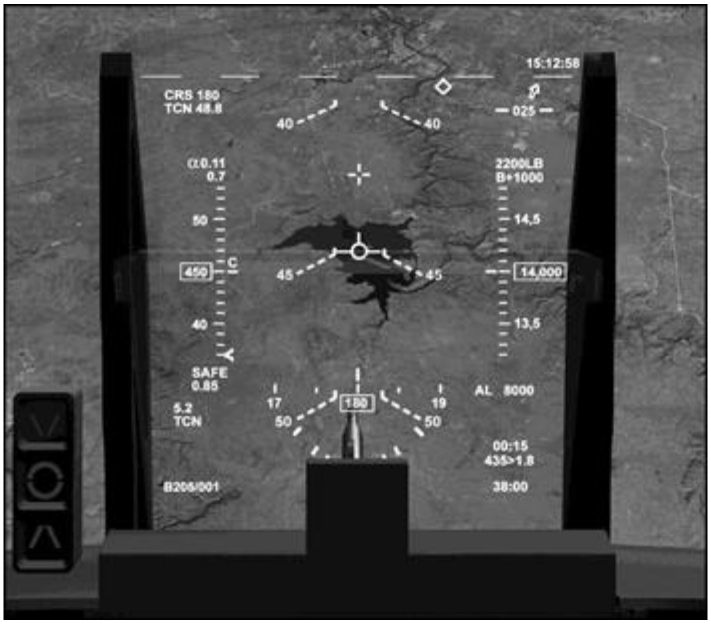
5.39.3. An Immelmann will require approximately 1 NM forward and 8,000 to 10,000 feet above.

5.40. Cuban Eight.

5.40.1. Entry parameters are 500 KCAS using MIL power.

5.40.2. Begin the Cuban eight by using the same mechanics as a loop. Continue to pull through the inverted, level-flight attitude. As the aircraft approaches a 45-degree, nose-low inverted attitude, relax backstick pressure and execute a half roll in either direction. Set the FPM (or CDM) approximately 45 degrees nose-low and hold it until beginning the next 4.5 to 5 G pull-up (**Figure 5.2**). In the 45-degree dive, the G loading will be approximately 0.7 to hold the dive angle and aimpoint. In the dive, look through the HUD, and pick an object on the ground and don't let it move in the HUD. Do not allow the nose to drift up as airspeed increases until initiation of the pull-up.

Figure 5.2. Cuban Eight.



5.40.3. To obtain entry airspeed for the second half of the maneuver, lead the pull-up by approximately 50 knots (10 knots for each 10 degrees nose-low). Initiating a 4.5 to 5 G pull at 450 KCAS will allow the aircraft to descend another 2,500 to 3,000 feet before the FPM passes through the horizon. Repeat the entire maneuver, except at the 45-degree, nose-low inverted attitude, the direction of roll will be opposite that of the first roll. Complete the maneuver in level flight, at entry speed, and heading in the original direction.

5.40.4. A Cuban eight will require approximately 1 NM forward, 2 NM behind, and 8,000 to 10,000 feet above.

5.41. Cloverleaf:

5.41.1. Entry parameters are 450 KCAS using MIL power.

5.41.2. A complete cloverleaf consists of four identical maneuvers (“leaves”), flown consecutively and in the same direction, with each entry heading 90 degrees from the previous one.

5.41.3. From level flight, choose a 90-degree reference point and then begin a 2 to 3 G pull-up. Approaching 45 degrees of pitch, begin a slow, rolling pull to lay the aircraft on its back at your selected 90-degree reference point. The airspeed should be between 175 to 200 KCAS as the aircraft passes through the inverted, level-flight attitude.

5.41.4. The pullout part of each “leaf” resembles a split-S. Smoothly increase backstick pressure to maintain the light buffet as the Gs increase. After passing the nose-low, vertical position, adjust backstick pressure to arrive at the level-flight attitude with entry airspeed. Continue the maneuver by starting the next “leaf.”

5.41.5. A cloverleaf will require approximately 3 NM forward, 2 NM in the direction of the first turn, 3 NM opposite the direction of the first turn, and 8,000 to 10,000 feet above. **Note:** Because most of a cloverleaf will be away from your first turn, you should turn into the closest border for the first leaf.

Chapter 6

FORMATION

Section 6A—Formation Administration

6.1. Introduction. The purpose of flying formation is to provide the mutual support required to accomplish a given mission. Whether the mission is air superiority, interdiction, or close air support, mutual support is essential for mission accomplishment. More than any other type of flying, formation provides the best environment for building confidence and for teaching self-reliance, self-discipline, and the proper application of aggressiveness in military flying. Procedures used in formation typically remain the same whether in two-ship or larger formations. Differences in procedures will be highlighted throughout this chapter.

6.2. Responsibilities:

6.2.1. Flight Lead. ***The flight lead is ultimately responsible for the safe and effective conduct of the mission.*** The flight lead plans, briefs, and debriefs the flight. This position gives both the authority and the responsibility to ensure the flight proceeds as intended. The flight lead must concentrate efforts on accomplishing the mission, achieving objectives, and returning with the flight intact. The flight lead must consider the capabilities of all flight members in planning a sortie. Taking this into consideration, the flight lead should optimize training for all flight members and plan missions accordingly, to include briefing mission-specific parameters.

6.2.1.1. Nav Lead. This may be used when the flight lead wants the wingman to navigate and clear. The lead will fly the wing position, deconflict within the flight, and keep the radios (for example, battle damage [BD] check).

6.2.1.2. Administrative (Admin) Lead. This is used to pass lead responsibilities to another member of the flight. The admin lead is expected to run all aspects of the profile to include navigating, managing the radios, and making changes to the profile if external conditions dictate. With an admin lead change, the aircraft within the flight are administratively renumbered to match the position being flown (for example, Sling 11 is now “2” for intraflight communication purposes but retains Sling 11 as his or her callsign). However, the flight lead still retains ultimate authority for the formation. Flight leads should consider passing the squawk with the admin lead to allow the aircraft primarily responsible for clearing outside the flight to have the traffic collision avoidance system (TCAS) available (for example, when splitting fuel and number 2 gets the lead during a UFT or PIT mission, or when number 3 is given the lead during a four ship).

6.2.1.3. Tactical Lead. This may be used when the flight lead needs the wingman to lead an event or segment of the flight. In this case, the wingman would pick up tactical, navigation, and radio responsibilities, but not the overall flight leadership responsibility.

6.2.2. Wingmen. Wingmen must be tasked commensurate with their skill to achieve the mission. Tasks include mission planning, threat study, and providing information in the brief. Once airborne, the wingman must execute the plan as briefed. Whether the flight is taxiing out to the runway or flying up initial, look and sound good, match lead’s configuration and always anticipate, never assume, and always have an aggressive attitude. To contribute successfully, wingmen must prioritize tasks based on the phase of flight. Accomplishing the following responsibilities in order will help safely execute the mission: Aviate, Navigate, Communicate! In other words, fly your jet, stay visual, be in the perfect formation (or aggressively correcting), then do everything else (FENCE-ing in (reference **paragraph 6.5.2**), managing avionics, changing radios, etc.). As proficiency and task management allow, the wingman should also strive to back up the flight lead.

6.2.3. Flight Discipline. The effectiveness of a formation mission is highly dependent on solid flight discipline, which begins with mission preparation and continues through briefing, ground operations, flight, and debrief. Mission effectiveness requires an in-depth knowledge of flight rules, unit standards, and procedures. When lead establishes the precedent, those orders must be followed. However, the wingman must speak up rather than allow the flight to enter an unsafe or unauthorized situation. If directed tasks are beyond a wingman's ability, the wingman must immediately inform lead. Uncompromising flight discipline is absolutely essential for successful mission execution.

6.2.4. Collision Avoidance. Each aircrew member shares the responsibility of avoiding a collision. The wingman retains primary responsibility for deconfliction between flight members. This responsibility transfers to lead if the wingman becomes blind or is placed in a blind cone during maneuvering. If any conflict develops between flight members, they should take immediate action and then transmit their intentions as time permits ("Reno 2 is going high."). They should also avoid attempting to direct other flight members because they may misunderstand or be unable to perform the directed course of action.

6.2.4.1. Lead. Flying in the lead position allows the most flexibility to clear visually for the flight while interpreting traffic calls from ATC. Lead should focus on avoiding traffic and maintaining a safe altitude above the ground. If a wingman becomes blind or placed in a blind cone during tactical maneuvering, lead will assume responsibility for intraflight deconfliction. If a wingman calls "padlocked", the wingman will maintain deconfliction. Lead will maneuver to alleviate the padlock situation.

6.2.4.2. Wingmen:

6.2.4.2.1. Normally, wingmen will ensure deconfliction. If any conflict exists between flight members, the wingman should maneuver predictably and then transmit specific intentions, affording the other aircraft a means to deconflict. For example, the wingman will transmit, Reno 2 is going low," while crossing lead's flightpath in a delayed turn nearly in-plane. The transmission indicates Reno 2 will be maneuvering below lead to remain well clear. Lead may then maneuver anywhere away from the wingman's predictable POM. This technique prevents an aircraft from directing a course of action the other aircraft may be unable to perform.

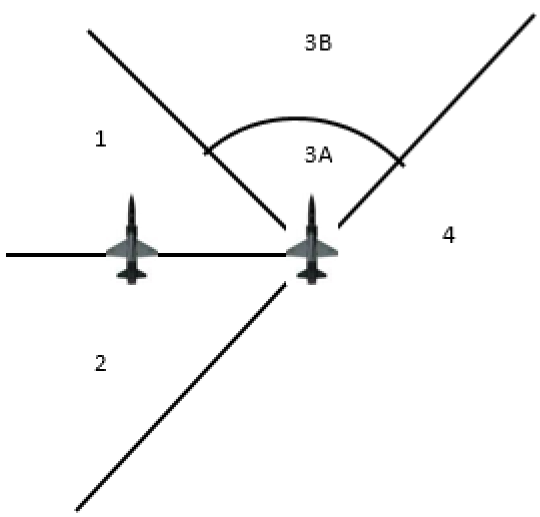
6.2.4.2.2. While maintaining position in formation, wingmen also have standard visual lookout responsibilities. If they discover a traffic conflict, they will initiate a directive call to eliminate any conflict. They will follow with a descriptive call to allow other flight members to acquire the traffic and maneuver appropriately. The descriptive call should follow the bearing, range, and altitude (BRA) format, for example, "Reno 21, climb, traffic, 12 o'clock, 1 mile, level." Wingmen will also provide mutual support by maintaining SA through calls from controlling agencies describing the position of potential traffic conflicts.

6.2.5. Visual Lookout. All flight members share visual lookout responsibilities. Excellent visual lookout depends on the ability to focus and refocus the eyes at appropriate ranges throughout the flight. Lookout priorities can change at a moment's notice, depending on the mission, weather, threats, altitude, and formation. As a technique, tactical formation lookout priorities are depicted in **Figure 6.1**.

6.2.5.1. Lead. In addition to briefing visual lookout responsibilities, lead must clear in the direction of the flight, focusing on avoiding traffic and maintaining a safe altitude above the ground. While employing in a tactical formation, lead shares responsibility with wingmen to visually clear for threats and traffic conflicts.

6.2.5.2. Wingman. The wingman's primary job is to execute disciplined visual lookout without sacrificing proper formation position or deconfliction responsibilities. Emphasis on deconfliction is directly related to aircraft proximity. For example, in fingertip, deconfliction requires more attention than in route or tactical. Beyond fingertip, the wingman must continue an active and systematic visual lookout with an emphasis on deconflicting with other flight members. Visual lookout priorities should be briefed by lead.

Figure 6.1. Wingman Visual Lookout Priorities in Tactical Formation.



6.2.5.3. Traffic Conflict. Initiate a directive call to eliminate immediate conflict. Follow-up the directive call with a descriptive call to allow other flight members to acquire the traffic and maneuver appropriately ("Buzz 21, climb, traffic 12 o'clock, 1 mile, level"). TCAS can aid in awareness of potential traffic conflicts but shouldn't replace a vigilant visual lookout. Cross-checking the TCAS will help to focus your visual search as well as adjust your flightpath if necessary. If a TCAS intruder will pass within 1 mile or 1,000 feet of the formation without visual contact, consider a directive call to maneuver the formation away.

6.2.6. Fuel Awareness:

6.2.6.1. All flight members must understand the factors to consider in determining joker and bingo fuel. Afterburner should not normally be used after reaching bingo fuel unless required for safety of flight. Flight members should increase their frequency of fuel checks during high fuel flow operations (for example, extended trail (ET), fluid maneuvering, and low altitude training). Lead must continually monitor the flight's fuel state and adjust the profile, frequency of ops checks, and joker or bingo, as necessary.

6.2.6.2. Unless already established on the return to base (RTB) phase of flight, wingmen will inform lead when reaching joker and bingo and receive an acknowledgment. If fuel drops below joker before informing lead, wingmen will reference the fuel state from bingo ("Iron 2 is bingo plus 1.").

6.2.6.3. **Radio Discipline and Procedures.** ***Preface all communications to external agencies (except for wingman acknowledgment) with the complete flight callsign.*** Communications are a good indicator of flight discipline. Radio calls should normally begin with the full callsign ("Ground, Sling 11, taxi 4 T-38s with Zulu" or "Reno 11, FENCE-in"). Voice recognition is often a significant factor in tactical operations, but it should not be relied upon for primary identification or communications. Intraflight radio calls to a specific position should reference that position ("Bam 2, breakout."). Normally, flights will operate on UHF- with outside agencies and very high frequency (VHF) intraflight. As a technique, VHF can be referred to as "Aux". Setting split volumes could help determine which radio is being used by lead. Wingmen should acknowledge "go" radio frequency changes with callsign and position ("Mega 21, cleared as filed, squawk 2345, go channel 4," acknowledgments: "2, 3, 4"); do not acknowledge radio frequency changes initiated with "push." In most cases, wingmen will mimic lead's radio transmissions.

6.2.6.3.1. Lead. Ensure calls are clear and concise, and combine calls when practical. Delay frequency changes or flight check-in as necessary based on wingman proficiency or flight conditions.

6.2.6.3.2. Wingmen. Change radio frequencies only when directed by lead. When performing a channel change, maintain your formation position unless otherwise prescribed or briefed. During task intensive situations such as IMC fingertip, if unable to change frequencies, maintain the proper position, and communicate on the intraflight frequency until the channel change can be accomplished. To minimize head-down time, a technique is to identify the raised "5" button on the UFCP. UHF preset frequencies may be incremented or decremented via the "2" or "8" buttons by feel and then visually confirmed. Wingmen will mimic the format of lead's calls, but will provide accurate information ("Vega 31, Ops Check," "1 is 2.3, 5 Gs," "2 is 2.1, 4.5 Gs," etc.). Unless briefed, lead speaks for the flight when communicating with other agencies until flight split up. Wingmen will normally respond to all directive calls, unless briefed otherwise or if the wingman's action is obvious. Query lead if calls are unclear.

6.3. Not Used.

6.4. Visual Signals:

6.4.1. ***When using visual signals, use AFI 11-205, Aircraft Cockpit and Formation Flight Signals, to the maximum extent possible. Any nonstandard visual signals must be briefed.*** Do not hesitate to use the radio to avoid confusion. To minimize confusion, only the pilot at the controls should give visual signals to another aircraft in the formation. Visual signals must be clear and appropriate for range (for example, slight wing rock to reform from route versus large wing rock from tactical).

6.4.2. Wingmen should acknowledge all visual signals. This acknowledgment may take the form of a head nod, a thumbs-up, or a change in formation position as appropriate. To minimize confusion, make your head nod big and clear. If a wingman does not acknowledge a signal, it should be interpreted as a request for clarification. Repeat the signal or make a radio call. Pass visual signals down the line, if appropriate.

6.5. Inflight Checks. ***Each flight member must accomplish required checks***. Visual signals or radio calls from lead may be used to initiate required checks for the appropriate phase of flight. Wingmen should be given an appropriate amount of time to complete inflight checks. Lead should adjust the formation position if necessary based on wingmen's skill level. Lead should also avoid any abrupt maneuvering to afford wingmen time to accomplish cockpit tasks without compromising deconfliction abilities. While performing inflight checks, wingmen will continue to prioritize their attention on lead, using only short glances to perform cockpit duties.

6.5.1. Ops Check. When conducting ops checks on the radio, use the following format ("Buzz 31, Ops Check, 1 is 2.3, 5.5 Gs", "2 is 2.2, 5.8 Gs"). If accomplishing an admin portion of the mission (departure, RTB, etc.), Gs need not be included. Upon completion of ops checks following high-G maneuvering (i.e., > 4 Gs), pilots may reset their G meter.

6.5.2. FENCE Check. "FENCE-in" is normally directed by lead upon entering the MOA/route. "FENCE-out" will normally be accomplished exiting the MOA or route at lead's direction. Items to accomplish will vary with the mission type and will change during follow-on training. You may accomplish items in any meaningful sequence or cockpit flow. Use the following format ("Bully 01 Fence In/out", "2, 3, and 4"). The FENCE acronym is one good technique for accomplishing required items in UFT and is explained as follows:

6.5.2.1. **F** ire Control - Master Arm and EGI Master Mode (NAV, air-to-air [A/A], or air-to-ground [A/G])

6.5.2.2. **E** mitters - TCAS, A/A TACAN, radios, and RALT

6.5.2.3. **N** AVAIDS - HSD and area setup

6.5.2.4. **C** amera - Confirm VTR on

6.5.2.5. **E** lectronic Countermeasures (ECM) - CMD

6.6. Lead Changes. Lead changes require a clear transfer of responsibilities from one flight member to another. ***During the lead change, both pilots must monitor the other aircraft to ensure separation is maintained.***

6.6.1. ***Do not initiate lead changes with the wingman further aft than a normal fingertip or route position, or greater than 30° aft from line abreast. Flight or element leads will not initiate a lead change unless the aircraft assuming the lead is in a position from which the lead change can be safely initiated and visual contact maintained*** . When a lead change is done from a close formation, the designated wingman moves out and forward to ensure wingtip separation while primarily focusing attention on lead. The wingman accepts the lead after reaching lead's 3/9 line and assumes lead responsibilities. As a technique, reference the canopy bow between the FCP and RCP to assess 3/9 line. The old lead will assume wingman responsibilities. Unless changed by the new lead, the formation will remain in the formation from which the position change was initiated. For example, if the position change was initiated from route, the flight will remain in route.

6.6.1.1. Lead Change Comm Example from Tactical.

6.6.1.1.1. Fiend 01: "Fiend 2, you have the lead on the left/right."

6.6.1.1.2. Fiend 02: "Fiend 2 has the lead on the left/right."

6.6.2. ***Three- and four-ship lead changes will be accomplished over the radio, and the new lead will acknowledge.***

6.6.2.1. **4-Ship Lead Change Comm Example** .

6.6.2.1.1. Octane 01: "Octane 3, you have the lead on the left/right."

6.6.2.1.2. Octane 03: "Octane 3 has the lead on the left/right."

6.7. Ground Operations:

6.7.1. Chocks. Engine start and check-in procedures will be IAW unit standards or as briefed. If delays occur, inform the flight lead as soon as possible but not later than the briefed check-in time. If visual, pass a thumbs-up to lead when ready.

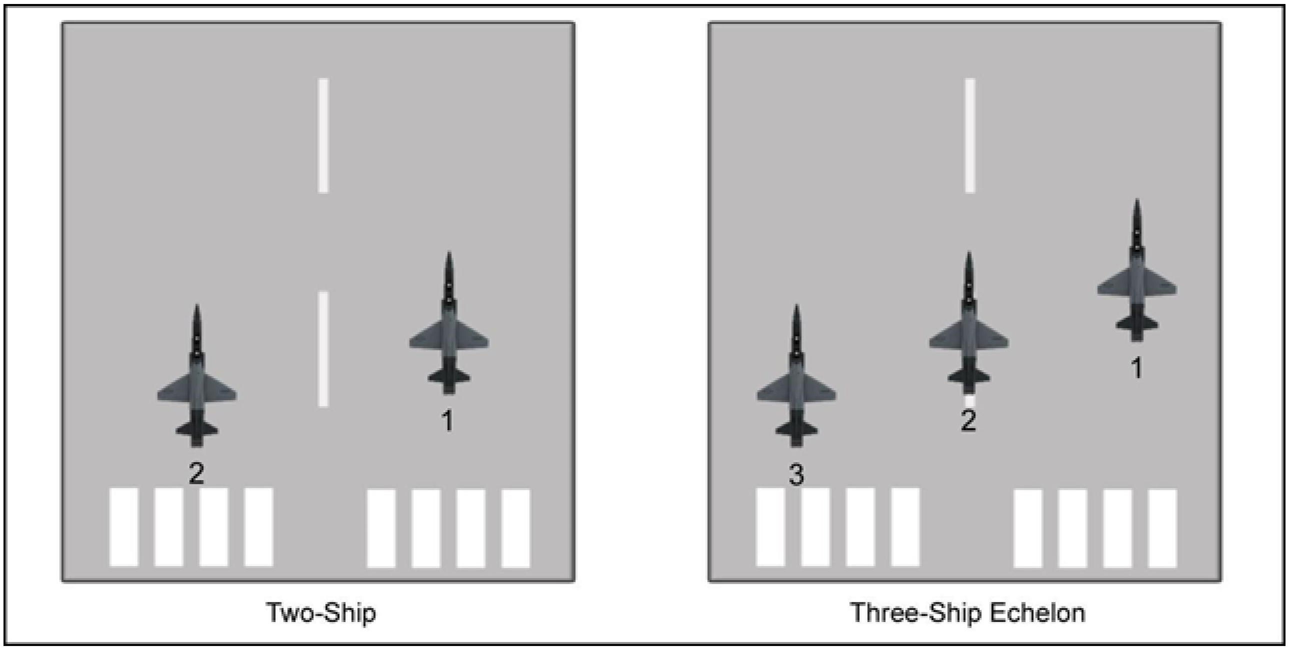
6.7.2. Taxi. Lead should taxi at a speed that allows wingmen to attain proper spacing. Wingmen will match lead's configuration, inspect each other for proper configuration and abnormalities prior to takeoff, and continue inspecting throughout the sortie. An approximate reference for 150-foot staggered spacing is the 2.5-degree pitch-line just under the main gear of the preceding aircraft.

6.7.3. Runway Lineup (Two-and Four-Ship). Runway lineup is normally determined by wind direction and other factors such as direction of traffic and weather turn out. Lead will ensure wingmen have sufficient room to maneuver into position. ***Minimum wingtip spacing is 10 feet wingtip clearance,*** but may be wider as desired or required. ***On the runway, a head nod is used for visual signals instead of a thumbs-up.*** **Note:** ***Always ensure 50 feet of wingtip spacing within an element if either crew is solo.***

6.7.3.1. Two-Ship. Each aircraft will usually take the center of its half of the runway. Wing will line up lead's main gear doors as a fore and aft reference (**Figure 6.2**). ***Once in position with canopy closed, the wingman will give lead a head nod to signal ready for engine run-up.***

6.7.3.2. Three-Ship. Normal three-ship lineup is echelon (**Figure 6.2**). If required however, three-ship formations may use any four-ship lineup as briefed. **Note:** ***Always ensure 50 feet of wingtip spacing between adjacent aircraft if either crew is solo.***

Figure 6.2. Two-Ship/Three-Ship Runway Lineup.

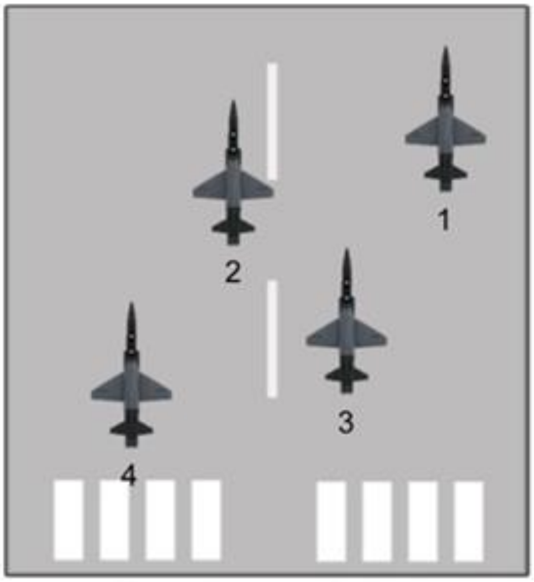


6.7.3.3. Four-Ship. Number 3 or 4 can line up in the slot. In either case, lead should line up as far to the side of the runway as practical. Number 2 will place the wingtip closest to lead on the centerline and line up the gear doors.

6.7.3.3.1. Number 3 in the Slot. Normally a four-ship lineup will have number 3 in the slot. Number 3 lines up between lead and number 2, pushing forward to clearly see number 2's visual signal and ***maintaining nose-tail clearances***. Number 4 will line up offset from number 2's jet blast while aligning the gear doors of number 3 (**Figure 6.3**).

6.7.3.3.2. Number 4 in the Slot. Number 3 will line up with wingtip clearance on Number 2 in echelon position. Number 4 will pull in between lead and number 2 with nose-tail clearance (**Figure 6.3**).

Figure 6.3. Four-Ship Runway Lineup.



Four-Ship (#3 in the Slot) Four-Ship (#4 in the Slot)

6.7.3.3.3. Four-Ship Signals. ***Number 4 will use a head nod to signal ready for engine run-up, and the signal will be relayed up the line (4—3—2).*** Number 3 may need to relay the ready signal via the radio if the lead element is displaced down the runway.

6.7.4. Engine Run-up. Once all aircraft have signaled "ready," lead may direct run-up visually or over the radio. ***During the engine run-up, continue to primarily focus your attention outside the aircraft with only short glances inside the cockpit. Signal ready for takeoff with head nods up the line***. If three is unable to see two for any reason, call "ready" after receiving four's head nod.

6.8. Formation Takeoff:

6.8.1. Lead:

6.8.1.1. ***A helmet tap is the preparatory command for brake release and selecting MAX afterburner. The execution command is a head nod*** . As your chin hits your chest, simultaneously release brakes and select MAX, reduce power slightly on both engines (approximately 60 percent nozzles but ***not less than minimum afterburner***), and verify both afterburners have lit.

6.8.1.2. Confirm wingman is safely airborne before retracting the gear and flaps. The visual signal for gear retraction is the gear doors opening. Begin a smooth power reduction out of MAX between 220 and 280 KCAS, and terminate afterburner operation by 300 KCAS. Monitor wingman throughout the takeoff. Pay close attention to airspeed to prevent the possibility of overspeeding gear or flaps during the takeoff.

6.8.2. Wingmen:

6.8.2.1. Monitor lead for the preparatory and execution signals**.** Release the brakes and aggressively advance the throttles to MAX afterburner when lead's chin hits his or her chest. Tap brakes as required to maintain position initially. Do <u>not</u> ride the brakes in an attempt to stay behind the lead aircraft. Confirm two good afterburner lights.

6.8.2.2. If a substantial power advantage or disadvantage is apparent, request one increase or decrease in power (for example, "Rocky 3, give me one/push it up."). ***Use caution to prevent pulling the throttles out of afterburner. If wing cannot remain in position (either overrunning lead or falling behind) with power set between minimum and MAX afterburner, wing should check both throttles in MAX, maintain separation from lead, and perform a separate takeoff***.

6.8.2.3. Rotate with lead's aircraft and concentrate on maintaining a proper position. Normally, the first indication of lead's rotation will be the movement of the stabilator or the extension of the nose gear strut. Duplicate lead's pitch attitude for lift-off.

6.8.2.4. When both aircraft are airborne, maintain a stacked-level position until retracting the gear and flaps. The visual signal for gear retraction is lead's gear doors opening. ***Confirm the gear and flaps are retracted then move into fingertip.***

6.8.2.5. After takeoff, if ahead of lead, check slightly away from lead, while continuing to fly off lead, if possible. Lead may pass the lead to wing if conditions warrant.

6.8.3. Interval Takeoff. When ready for takeoff, lead will release the brakes and perform a takeoff. Wingmen will delay brake release ***a minimum of 10 seconds for a single aircraft or 15 seconds for an element takeoff*** after the preceding aircraft. If not executing a 2+2 interval takeoff, each aircraft should steer toward (but not cross) the center of the runway after the start of the takeoff roll. To help expedite the rejoin, lead should terminate afterburner early (220 knots minimum), continue to accelerate to 300 KCAS in MIL power, and climb at a reduced power setting. ***Unless briefed otherwise, number 2 will rejoin to the inside of the first turn out of traffic***. If necessary, coordinate for an intermediate level-off to maintain visual VMC until wingmen are joined. Wingmen should delay coming out of afterburner until sufficient overtake is achieved.

6.8.4. Rolling Interval Takeoff. When cleared for takeoff, lead will taxi into position and perform a normal single-ship rolling takeoff then follow the procedures above. After takeoff has been initiated by lead, wing will taxi into position and perform a normal single-ship rolling takeoff with a ***minimum of 10 seconds*** interval.

6.9. Instrument Trail Departure:

6.9.1. When flying an instrument trail departure, the first priority is to follow basic instrument flying procedures. Strictly adhere to the briefed climb speeds, power settings, altitudes, headings, and turn points. ***All aircraft will use 30 degrees of bank for all turns. Takeoff spacing will be no less than 20 seconds.*** Unless briefed otherwise, each aircraft or element will climb at 300 KCAS with 600 degrees EGT and maintain briefed spacing until all aircraft have reached VMC and are cleared to rejoin.

6.9.2. ***Until join-up, each pilot or element lead will call with altitude and heading when passing multiples of 5,000 feet and when initiating any altitude or heading change.*** As a technique, DME can be added to this call if it enhances situational awareness. ***Until visual***

contact, each pilot or element will maintain at least, 1,000 feet of vertical separation from the preceding aircraft or element except where departure instructions specifically prohibit compliance. If 1,000 feet of separation prevents the wingmen from complying with the minimum safe altitude, lead may reduce the vertical separation to 500 feet.

6.9.3. If a visual join-up at level-off is not possible, lead should request 1,000 feet of altitude separation for each succeeding aircraft or element. ***Wingmen will call visual on preceding aircraft and rejoin only after directed by flight lead***. If local procedures allow, use the TCAS to aid in enhancing positional awareness on all formation members. Do not allow this additional SA tool to detract from precisely flying instrument trail departure procedures.

6.10. Area, MOA, or Route:

6.10.1. G-Awareness Exercise. Formation G-awareness exercises should be flown from line-abreast tactical formation (in four-ship wall or box formations only) as described in paragraph 6.28 for two-ship and paragraph 6.43/6.44 for four-ship. Normally, perform two 180-degree turns for formation G-awareness exercises. ***Maintain a minimum of 4,000 feet lateral separation between all formation members.*** While maintaining deconfliction, emphasis should be on the AGSM, G-awareness, and correct operation of equipment, <u>not</u> on perfect formation position.

6.10.2. After completion of the G-awareness exercise, wingmen will deconflict, select MIL power, attain 350 KCAS, and regain tactical formation position.

6.11. Knock-It-Off (KIO) and Terminate Procedures. Use KIO or terminate procedures to direct aircraft to cease maneuvering. A KIO or terminate applies to any phase of flight and all types of missions. Refer to AFI 11-2T-38, Volume 3, as supplemented.

6.11.1. ***Any flight member can initiate a KIO or terminate. Make directive radio calls if danger is imminent. Call KIO when safety of flight is a factor or where doubt or confusion exists. Call terminate when safety of flight is not a factor.***

6.11.2. ***Initiation of a KIO or terminate will start with flight callsign, followed by each flight members transmitting his or her position number—in order—with "knock-it-off" or "terminate". Aircraft with radio failure will signal KIO with a continuous wing rock.***

6.11.3. For example, if anyone transmits, "Iron 11, knock-it-off", all flight members will respond as follows: "Iron 1 knock-it-off", "Iron 2 knock-it-off", "Iron 3 knock-it-off", "Iron 4 knock-it-off". When hearing a KIO or terminate call, or observing a continuous wing rock, all participating aircrew will clear the flightpath, cease current maneuvering, climb or descend to a prebriefed safe altitude (1,000 feet AGL minimum), and acknowledge with callsign or a wing rock. If able, the aircraft that initiated the KIO or terminate will give the reason after the KIO drill is complete, if not obvious (for example, "Iron 2 engine flameout"). If any flight member fails to respond correctly, the sequence should be initiated again. Lead will be directive before resuming maneuvers.

6.12. Recovery:

6.12.1. Battle Damage (BD) Check:

6.12.1.1. Perform a BD check when directed by the lead aircraft from either fingertip or route. The signal is either a radio call or a visual "checkmark" signal. To perform the check, make a slight check turn away from lead (fingertip), and climb only as necessary to visually inspect the top of the near side of the aircraft. Continue the inspection by dropping down to inspect the lower side of the aircraft; perform a cross under; and inspect the lower and upper side of the opposite side of the aircraft. Upon completion, remain on that side and assume the proper formation position. While inspecting the other aircraft, look for any damage, leaks, missing panels, or any irregularities.

6.12.1.2. During the BD check, the aircraft fulfilling appropriate lead responsibilities must navigate and clear for the formation (NAV lead) while the wingman maintains deconfliction within the formation.

6.12.1.3. Use the intraflight radio to pass discrepancies; otherwise, pass a thumbs-up after returning to the formation position (fingertip/route) from where the check started. The lead aircraft then passes the lead to the wingman and performs a BD check.

6.12.1.4. For a three- or four-ship BD check, lead will direct number 2 to check the flight. All other aircraft will maintain position while number 2 checks the entire formation and returns to the original position. When number 2 is in position, number 3 (three-ship) or number 4 (four-ship) is automatically cleared to check number 2.

6.12.2. Splitting the Flight. ***When splitting the flight becomes necessary, lead will verify that wingmen have a positive fix from which to navigate*** and coordinate with ATC for separate clearances.

6.12.3. Formation Approach and Landing. Normally, the best wingman consideration a lead can offer is to fly the best single-ship approach and landing possible. ***Lead will position the wingman on the upwind side of the runway if crosswinds are greater than 5 knots***. Gear and full flaps are normally lowered with one visual signal or radio call unless briefed otherwise.

6.12.3.1. Lead. After confirming a safe gear indication for both aircraft, transmit a “gear down” call for the flight. After reaching VMC and when able to maintain visual contact with the runway on short final, line up with the center of the appropriate side, and establish an aimpoint that will allow a touchdown approximately 500 to 1,000 feet beyond the threshold. Unless one aircraft will circle, fly the final approach airspeed for the heaviest aircraft. ***If either aircraft will circle from the approach, configure with 60 percent flaps and final turn airspeed for the heaviest aircraft.***

6.12.3.2. Wing:

6.12.3.2.1. Fly normal fingertip references (see para 6.13.1) until on glidepath. Assume the “stack level” position when VMC or on glidepath (whichever occurs later), or as briefed. The vertical reference for stacking level is to place the helmet of the front cockpit pilot in the lead aircraft on the horizon. The FCP visual reference for fore and aft is head abeam the slab bolt; lead’s main landing gear should resemble a figure 8 at 50 feet of spacing (**Figure 6.4**). The RCP visual reference for fore and aft is head abeam the aft edge of the burner cans (space between lead’s main landing gear). Lateral spacing ranging from 10-feet to 50-feet wingtip clearance should be adequate in all cases, provided the lead aircraft lands near the center of his or her side of the runway. Attempt to stabilize at a given spacing in the 10- to 50- foot range, as briefed or as directed by other guidance (syllabus or unit standards). See Table 6.1 for front and rear cockpit references for wingtip clearances of 10 feet, 25 feet, and 50 feet.

Figure 6.4. Formation Approach Stack Level, 25 and 50 foot spacing.

Table 6.1. Spacing References in the Stack Level Position.

ITEM	A	B	C
	Wingtip Clearance	**Front Cockpit**	**Rear Cockpit**
1	10 feet	Position light aligned with the leading edge of the gear door.	Look straight down the wing line.
2	25 feet	Position light in the center of the gear door.	Position light slightly forward of the leading edge of the gear door.
3	50 feet	Position light aligned with the trailing edge of the gear door.	Position light in the center of the gear door.

6.12.3.2.2. Lead is the primary reference for the wing landing. Cross-check the runway on short final to ensure proper alignment, and then fly the proper position off lead throughout the flare and touchdown. Once on the runway, maintain lateral spacing, use normal braking techniques, and in no case allow your aircraft to drift across the runway centerline.

6.12.3.2.3. After establishing nose-tail separation and under control, clear to the cold side of the runway. If landing on the cold side of the runway, turn off the landing light (at approximately taxi speed) to clear lead to the cold side.

6.12.3.2.4. If you overrun lead, accept the overrun and maintain the appropriate side of the runway. The most important consideration is wingtip clearance. Lead may pass the lead over the radio if conditions warrant.

6.12.4. Formation VMC Drag. These procedures may be used to achieve minimum runway separation of 3,000 feet between aircraft in formation when conditions prevent accomplishing a wing landing or visual flight rules (VFR) traffic pattern and landing. Prior to directing the formation to drag under instrument flight rules (IFR), lead will slow to 250 KCAS and coordinate with the appropriate ATC agency for nonstandard formation during the remainder of the approach. ***Lead will ensure that all aircraft will be able to maintain VMC from the drag point to landing before directing the formation to drag.***

6.12.4.1. The latest drag point will be 8 miles from the runway. On instrument final approaches, the drag is normally accomplished so as to establish separation prior to the final approach fix or glideslope intercept.

6.12.4.2. When lead directs the formation to drag, wing will select idle and extend speed brakes until airspeed is below 240 KCAS, then select landing gear down, flaps 60 or 100 percent, and speed brakes up. Wing will set TCAS appropriately as task management permits.

6.12.4.3. The wingman will maintain final approach airspeed minimum and remain within standard formation parameters.

6.12.4.4. Lead will maintain 250 KCAS until 5 miles from the runway, then select idle power and speed brakes down until below 240 KCAS. Below 240 KCAS, lead will select landing gear down, and flaps 60 or 100 percent, and speed brakes up.

6.12.4.5. ***Lead will maintain a minimum of 180 KCAS until 3 miles from the runway, and then slow to final approach speed.***

6.12.4.6. ***Wingmen will not fly below final approach airspeed and s-turns will not be used to gain or maintain separation while on final.***

6.12.5. Traffic Pattern:

6.12.5.1. Once established in the VFR overhead traffic pattern, turns away from wing will normally be in echelon. On or before turning initial, lead should place wingmen on the side opposite the direction of the break. Initial is usually flown in fingertip formation; route formation is more prudent with reported bird activity or other hazards; tactical initial may be flown IAW local guidance.

6.12.5.2. Lead should break at the beginning of the break zone. Wingmen will delay 5 seconds before initiating the break. This normally provides a minimum of 3,000 feet spacing. If greater spacing is required, the wingmen will delay the break (8 seconds normally provides 6,000 feet of spacing). When approaching the perch point, wingmen will cross-check the runway and lead to ensure proper spacing from both.

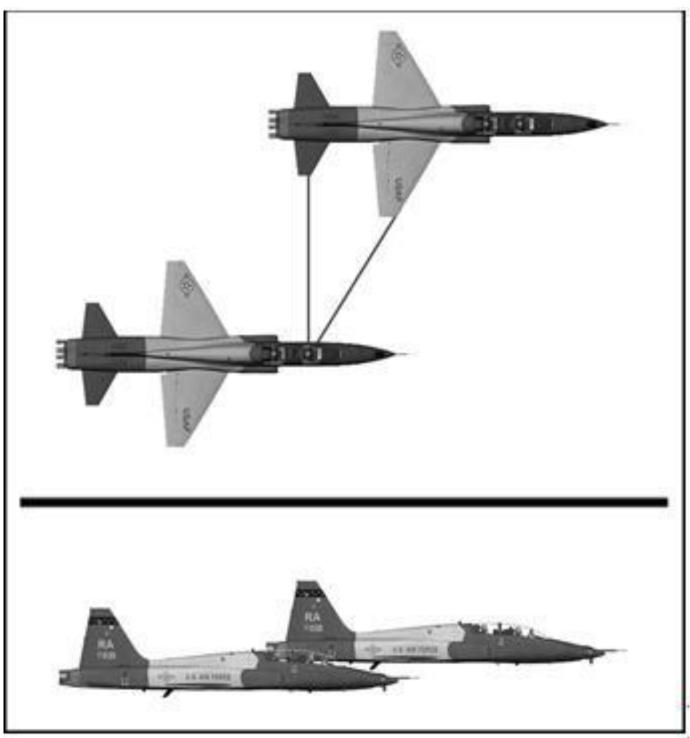
6.12.5.3. In a four-ship, lead and number 2 should avoid slowing so rapidly that trailing wingmen cannot maintain sufficient spacing.

Section 6B—Basic Formation

6.13. Fingertip:

6.13.1. Fingertip formation (**Figure 6.5**) is used for weather penetration, airfield arrivals and departures, and show formations. Wing will maintain wingtip clearance while flying a position from which the front cockpit (FCP) pilot looks down the leading edge of lead's wing. An FCP pilot position abeam the slab bolt provides approximately 3 feet of wingtip separation. "(**Note:** "Abeam the slab bolt" implies visually sighting along a line from the FCP to the front slab tip to the slab bolt as shown in **Figure 6.5**.) From the rear cockpit (RCP), lining up the position light with a point on the intake half way between the wing root and the lower leading edge of the intake (with head abeam the trailing edge of the burner cans) provides3 feet of wingtip clearance.

Figure 6.5. Two-Ship Fingertip.

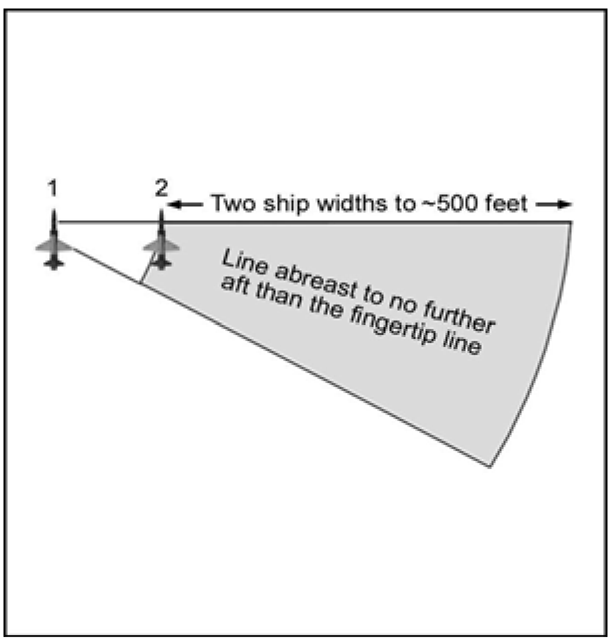


6.13.2. Wingwork Exercise. When accomplishing the wingwork exercise, fly a series of modified lazy eight maneuvers***, using up to 3 Gs and 90 degrees of bank*** in an airspeed range of approximately 200 to 400 KCAS. Lead will emphasize clearing, smoothness, and providing a stable platform with consistent, predictable roll rates and no sudden changes in backstick pressure. Wing will use small throttle or stick movements and trim to maintain position, while avoiding the tendency to stare at any one spot. Practice using all of lead's aircraft as a reference.

6.13.3. When flying fingertip in a 3- or four-ship formation, there is no difference for numbers 2 and 3. Number 4 will fly the normal fingertip position and strive to line up the helmets of numbers 1 and 3. When number 3 is adjusting, number 4 should consider flying a stable position off number 1 while monitoring and maintaining lateral separation from number 3.

6.14. Route Formation. A route formation (**Figure 6.6**) is flown to enhance clearing and visual lookout, increase flight maneuverability, and ease the completion of inflight checks, radio changes, and other cockpit tasks. Lead will send wingmen to route with a radio call or visual signal. ***Route is flown from two ship-widths of spacing out to approximately 500 feet.*** Fly no farther aft than the extended fingertip line, no farther forward than line abreast, and, when wings level, maintain a level stack. On the inside of a turn, stack below lead's POM only as necessary to keep lead in sight. On the outside of a turn, maintain the same vertical references used in echelon. In a three- or four-ship formation, number 2 sets lateral spacing for the formation. Number 3 should fly line abreast with number 2, matching lateral spacing from number 1. Number 4 should line up the helmets of numbers 3 and 1. Lead should limit bank angle to 60 degrees with wingmen in route. During a climb, the wingman should strive to stack slightly high signaling to lead that the wingman has more power available.

Figure 6.6. Route Formation.



6.15. Chase. Chase is used for a variety of reasons, including performance assessment and assistance during an emergency. ***Safety chase observers will maneuver in a 30- to 60-degree aspect cone out to 1,000 feet.*** The chase pilot is primarily responsible for aircraft separation.

6.16. Echelon:

6.16.1. Echelon is a multi-ship formation where all wingmen are on the same side of the formation. Lead directs the flight into echelon by dipping a wing in the desired direction or making a radio call ("Sling, echelon left/right").

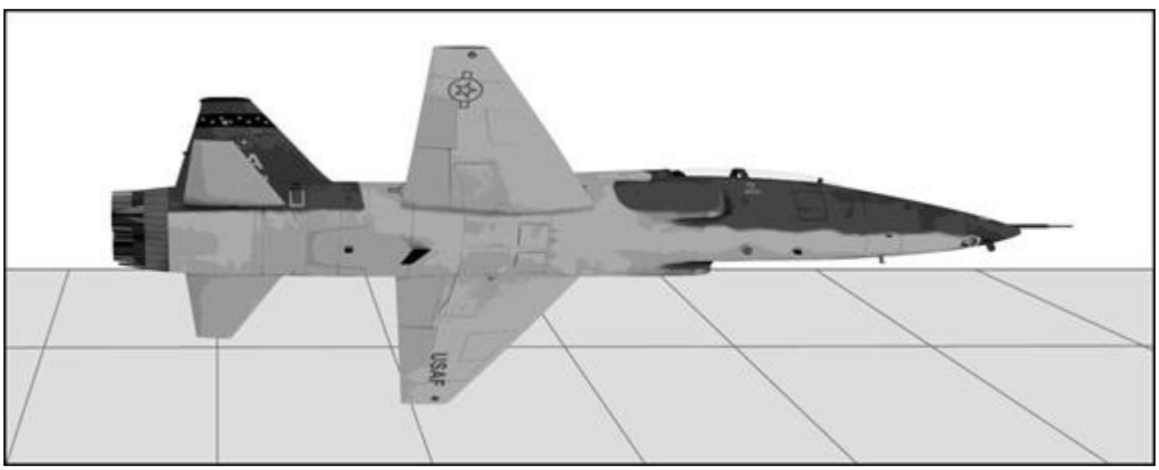
6.16.2. Unless prebriefed (like turns in the VFR overhead pattern), lead normally directs echelon turns with a radio call or visual signal for two-ship formations. In a three- or four-ship formation, an echelon turn is implied when the wingmen are on the same side. All aircraft must be very aware of the importance of smooth corrections, positive backstick pressure, and the need to avoid unloading while in the turn.

6.16.3. Echelon turns can be performed at a variety of airspeeds. A common technique as lead is to initiate echelon turns between 300 to 350 KCAS and to minimize throttle movements during the turn in order to give the wingmen a more stable platform to follow.

6.16.4. Except for very gentle turns into the echelon, always turn away from the echelon and plan to limit bank to 60 degrees maximum**.** Number 2 should match lead's roll rates. Once established in a turn, the horizon should split lead's lower intake (**Figure 6.6**). As in fingertip, the FCP pilot's helmet should be abeam the slab bolt. Use power to make fore/aft corrections, backstick pressure to maintain horizontal spacing, and bank to make corrections up or down.

6.16.5. When in the number 3 or 4 position, the basic references are the same as those for number 2. However, you should add lead's position in relation to the horizon to your cross-check, so as not to over adjust for every correction number 2 or 3 makes.

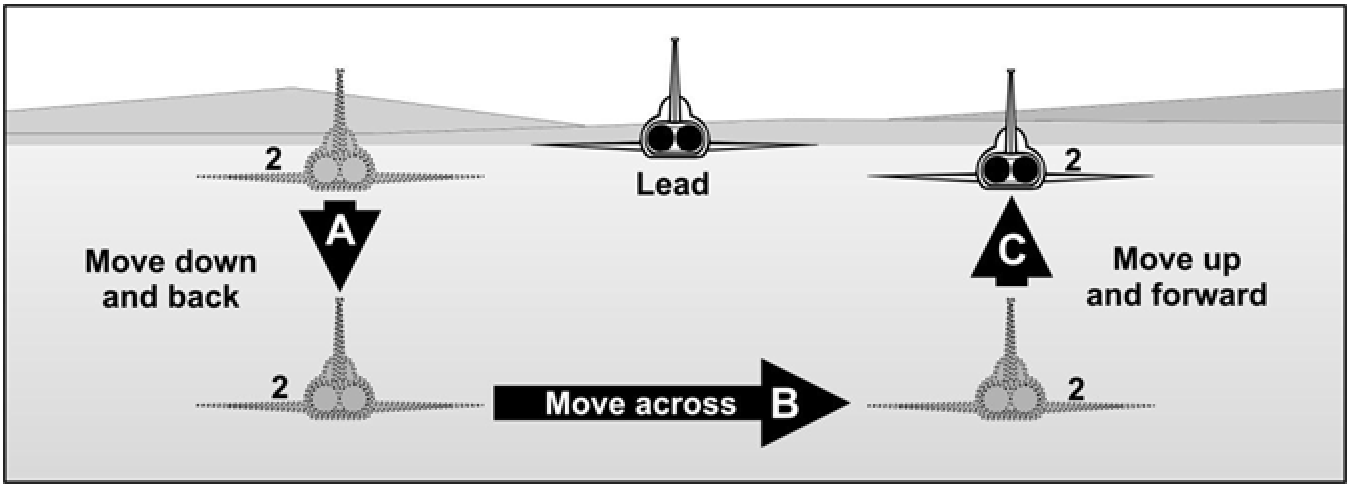
Figure 6.7. Echelon Turn.



6.17. Crossunder:

6.17.1. Two-Ship Crossunder. Except for prebriefed events (like the BD check), lead normally directs a crossunder with a radio call or visual signal. When using a wing dip signal, the size of lead's signal should be appropriate for the distance to the wingman. On lead's signal, the wingman reduces power as required until a small forward line-of-sight (LOS) rate develops. The wingman will move back and slightly below lead's POM and add power to stop lead's forward LOS. He or she will then move across and ***behind lead with a minimum of nose-tail clearance***, adding power as required so as not to fall any further behind. Once on the opposite side and with wingtip clearance, the wingman will add power to move up and forward into fingertip (Figure 6.8).

Figure 6.8. Crossunder.



6.17.2. Four-Ship Fingertip Crossunder. In a four-ship fingertip or route formation, a wing dip toward number 2 signals a crossunder for numbers 3 and 4, and a wing dip toward number 3 signals a crossunder for number 2. If number 2 is crossing to the side that numbers 3 and 4 are on, number 3 should smoothly move out to create room for number 2. Number 2 begins a normal crossunder, but must ensure adequate spacing before crossing lead’s 6 o’clock. As number 2 attains position, number 3 begins flying off number 2 while referencing lead. If numbers 3 and 4 are crossing simultaneously, number 3 begins smoothly dropping down and aft in a normal crossunder and establishes nose-tail clearance off number 2 before crossing. As number 3 begins the crossunder, number 4 performs a crossunder on number 3, normally crossing number 3's 6 o’clock as number 3 crosses behind lead. Number 4 must anticipate LOS rates and power changes to avoid falling aft.

6.17.3. Four-Ship Echelon Crossunder. In a four-ship echelon formation, lead's radio call or wing dip (always away from the echelon) directs the entire formation to change sides. Ideally, as number 2 begins the crossunder, all the wingmen move together. The entire formation is in a straight line as the wingmen cross lead's 6 o'clock. Then all the wingmen assume their position on the other side of lead. A wing dip toward the echelon is meaningless. Any other formation change, like returning to fingertip, requires a radio call.

6.18. Pitchout:

6.18.1. The purpose of a pitchout is to provide spacing for a rejoin or follow-on maneuvering. After the signal or radio call, lead clears and then turns away from the wingman, using G forces to attain 300 KCAS unless briefed or directed otherwise. Lead will normally fly a level turn of about 180 degrees. However, he or she may climb, descend, and (or) adjust the degrees of turn as necessary for weather, area orientation, or energy management. Lead will allow enough time for the wingmen to complete the pitchout, and then direct the rejoin with a radio call or visual signal.

6.18.2. Wingmen keep lead or the preceding aircraft in sight, delay 5 seconds (or as briefed), and then turn to follow, using about the same bank angle and G loading. A 5-second delay provides approximately 1 NM spacing. After turning approximately 90 degrees**,** the wingman will vary bank angle and backstick pressure as necessary to attain desired spacing. He or she will roll out behind and slightly below lead or the preceding aircraft, maintaining 300 KCAS until directed to rejoin.

6.19. Take Spacing:

6.19.1. Take spacing is normally used to increase range when reversing the direction of the flight is not practical (for example, practice rejoins). When these procedures are not specified in unit standards, they must be thoroughly prebriefed. These are VMC-only maneuvers.

6.19.2. Lead will direct the wingman to take spacing with a prebriefed visual signal or radio call. The wingman will acknowledge with a radio call or by maneuvering away from lead to take spacing. Spacing can be achieved with a combination of wingman maneuvers, wingman deceleration, and lead acceleration.

6.19.3. One technique, usually done at 300 KCAS, is to direct the wingman to take spacing, which the wingman does by performing a series of check turns behind and below lead's jet wash. When the desired spacing is achieved, the wingman calls "ready". If the plan is for a three- or four-ship to take spacing, procedures for each aircraft should be thoroughly briefed.

6.20. Practice Lost Wingman Exercise. This exercise exposes new pilots to procedures that are critical during lost wingman scenarios in actual instrument meteorological conditions (IMC). ***(Practice this exercise in two-ship formation, in day VMC, using the procedures in AFI 11-2T-38, Volume 3.)*** Lead will initiate a practice lost wingman exercise with a radio call. Lead will acknowledge the wingman's "practice lost wingman" radio call by transmitting attitude, altitude, heading, airspeed, and other parameters as appropriate. The wingman will execute the appropriate procedures, to include a radio call. The wingman may signify completion of the exercise (as determined and briefed by the flight lead) by calling visual. **Note:** The IP or safety observer in the wing aircraft will monitor lead to ensure separation throughout the exercise.

6.20.1. Practice Lost Wingman Comm Example.

6.20.1.1. Bully 01: "Bully 2, Go practice lost wingman."

6.20.1.2. Bully 02: "2". "Bully 2 is practice lost wingman."

6.20.1.3. Bully 01: "Bully 1, wings level, 15 thousand, heading 350, 300 knots."

6.20.1.4. Bully 02: "2". "Bully 2 visual."

6.21. Rejoins:

6.21.1. Overview:

6.21.1.1. The purpose of a rejoin is to get the flight back together safely and efficiently. Lead will initiate rejoins with a radio call or a visual signal (wing rock) and, when necessary for energy management or area orientation, may use slight climbs or descents during the rejoin. Lead should consider initiating the rejoin via a radio call, especially when lead cannot see wingmen.

6.21.1.2. Lead should monitor wingmen closely during all rejoins. Airspeeds and bank angles are normally prebriefed or unit standard. Lead should consider making a radio call if flying a different airspeed or bank angle. Wingmen should always use LOS cues and airspeed awareness when rejoining.

6.21.1.3. For standard rejoins from basic formation positions (other than tactical), lead will maintain 300 KCAS, and 30 degrees of bank, if turning. For standard rejoins from tactical, lead will maintain 350 KCAS, and 45 degrees of bank, if turning. The rejoin discussions in paragraphs 6.21.2 and 6.21.3 apply to rejoins from all formation positions, including the terminal phases of tactical rejoins. (The initial phase of tactical rejoins is discussed in **Section 6C**)

6.21.2. Straight-Ahead Rejoin:

6.21.2.1. Straight-ahead rejoins can be accomplished from a variety of situations, including pitchouts, take spacing, and instrument trail. A standard straight-ahead rejoin is to the left wing for number 2 and the right wing for numbers 3 and 4.

6.21.2.2. When initiated from a position behind lead (from a maneuver that places wingmen in trail at lead's 6 o'clock), fly to a position slightly below and at approximately 0 degree aspect angle (AA) from lead, avoiding lead's and preceding wingmen's jet wash. Using power for closure, 50 knots of overtake is usually adequate when starting from 1 nm. Approaching 2,000 feet, modulate power to arrive at 2,000 feet with approximately 20 to 30 knots of overtake. At 2,000 feet lead's wingspan is approximately 13 mils (the width of the HUD bore sight/gun cross. See Attachment 2, *Stadiametric Ranging*. At approximately 1,500 feet behind lead, the figure-eight design of the two tailpipes is visible, but two separate engines are not distinguishable. At this point, bid away from lead's 6 o'clock position to a route position, on the side to be rejoined to, and continue to reduce overtake. When you take your bid, put the wingtip of the flight path marker just outside of the wingtip of lead's aircraft. Maintain the new heading and do not check back into lead. If you recognize you took too large of a bid, check back to your original heading (parallel lead's fuselage), but do not reduce wingtip separation until you have reached the wingline. A technique to reduce overtake at this point is to retard your throttles at a rate equal to the aft LOS rate of lead on the canopy, such that lead's LOS freezes as you arrive in the route position. Use speed brakes as required to assist in slowing the LOS rate. Then, with your overtake under control, close from route to fingertip.

6.21.2.3. During a rejoin in a climb, the aircraft is more responsive to throttle reductions when decreasing overtake and slowing lead's aft LOS rate on the canopy compared to during a level-flight rejoin. A common error is for wing to stagnate during a climbing rejoin prior to reaching the fore/aft references for the route position. To prevent this, you should begin to reduce overtake later and the throttle movement should be slower and less than what is required during a level-flight rejoin. During a descending rejoin, the opposite is true. The aircraft is less responsive to throttle reductions when decreasing overtake and slowing lead's aft LOS rate on the canopy compared to a level-flight rejoin. A common error during the descending rejoin is for wing to overshoot the fore/aft references for the route position. Therefore, you should begin to reduce overtake sooner, and the throttle movement should be faster and more than what is required during a level-flight rejoin.

6.21.2.4. For three-ship and four-ship formations, aircraft will rejoin in the proper numerical sequence. Number 2 rejoins to the inside of the turn, and numbers 3 and 4 rejoin to the outside. When the flight lead uses a visual signal to initiate the rejoin, each wingman will repeat the signal for aircraft in trail. ***Maintain a minimum of 500 feet spacing from the preceding aircraft until that aircraft has stabilized in route. Rejoining aircraft will cross below the preceding aircraft's jet wash with a minimum of nose-tail clearance.*** Each aircrew will monitor the preceding aircraft's rejoin for excessive closure and anticipate overshoot and breakout situations from preceding aircraft.

6.21.3. Turning Rejoins:

6.21.3.1. Rejoins to Number 2 (Inside the Turn):

6.21.3.1.1. The visual signal for a turning rejoin is also a wing rock with the first wing dip in the direction of the rejoin. Because turning rejoins can be accomplished from many different positions, wingmen must initially assess the combinations of range, aspect, energy state, and heading crossing angle (HCA) to establish appropriate AA, pursuit curves, and overtake airspeeds.

6.21.3.1.2. After the rejoin signal and lead's turn, the wingman begins a turn in the same direction to create lead pursuit. Simultaneously establish vertical separation, establish approximately 30 knots of airspeed overtake, and adjust lead and lag pursuit to maintain moderate aspect angle.

6.21.3.1.3. Use the airspeed indicator and visual cues to judge closure on lead. Control closure by adjusting the pursuit curve (aspect angle) and the power. Use the speed brakes as needed, but plan the rejoin so that speed brakes are not required to complete the rejoin. Complete the rejoin to fingertip similar to reforming from the route position.

6.21.3.1.4. During a turning rejoin, wingmen should establish and maintain about 50 feet of vertical separation below lead's POM until stabilized in route formation. A technique for determining 50 feet of vertical separation is to use the length of lead's jet above the horizon. Lead will start climbing in the canopy as range decreases inside of 1,000 feet, but you will be able to see the horizon under them and above the canopy rail. Other airspeed aspect combinations may be used if needed to complete the rejoins. Regardless of the rejoin combinations, airspeeds should be less than 50 knots overtake for low aspect rejoins, 30 knots for medium aspect rejoins, and 10 knots for high aspect rejoins when within 3,000 feet of lead. Avoid the tendency to reduce closure by increasing G inside the turn.

6.21.3.2. Rejoins to Number 3 or Number 4 (Outside the Turn). For three-ship and four-ship formations, aircraft will rejoin in the proper numerical sequence. Number 2 rejoins to the inside of the turn, and numbers 3 and 4 rejoin to the outside. When the flight lead uses a visual signal to initiate the rejoin, each wingman will repeat the signal for aircraft in trail. ***Maintain a minimum of 500 feet spacing from the preceding aircraft until that aircraft has stabilized in route. Rejoining aircraft will cross below the preceding aircraft's jet wash with a minimum of nose-tail clearance.*** Each aircrew will monitor the preceding aircraft's rejoin for excessive closure and anticipate overshoot and breakout situations from preceding aircraft.

6.21.3.3. **Figure 6.9** shows three different visual references for various AA rejoins. View B (approximately 45 degree AA) is the preferred picture to maintain throughout the rejoin. This AA optimizes the use of airspeed and geometry while allowing flight lead the flexibility to maneuver the formation as necessary. View C (approximately 60 degrees AA) should be avoided because it demands too much flight lead monitoring, and view A (approximately 30 degrees AA) does not maximize the benefit of geometry or lead pursuit and potentially wastes fuel in a "tail chase".

Figure 6.9. Various Aspect Views.

6.22. Overshoots:

6.22.1. Overview. The purpose of an overshoot is to safely dissipate excessive airspeed or decrease excessive angular overtake during a rejoin. Wingmen must not delay the overshoot in an unusually aggressive attempt to "save" a rejoin. Keep lead and the preceding aircraft in sight at all times during any overshoot.

6.22.2. Straight-Ahead Rejoin Overshoot. A properly executed straight-ahead rejoin with excessive closure (Vc) will result in a pure airspeed overshoot several ship-widths out, with a slight diverging vector. Select idle and speed brakes (if required) as soon as excess overtake is recognized. Guard against turning back into lead while looking over your shoulder. A small, controllable 3/9 line overshoot is easily managed and can still result in an efficient rejoin. Retract the speed brakes and increase power just prior to achieving co-airspeed (stagnant LOS) to prevent falling aft.

6.22.3. Turning Rejoin Overshoot:

6.22.3.1. A properly executed turning rejoin with excessive Vc will result in a combination airspeed- aspect overshoot in a POM about 50 feet below lead. The decision to overshoot should be made early so the wingman crosses lead's low 6 o'clock with a minimum of approximately two ship lengths spacing. In all cases, ensure nose-tail separation can be maintained. Select idle and speed brakes as required, depending on excess airspeed.

6.22.3.2. Once outside the turn, use bank and backstick pressure as necessary to stabilize in route echelon position. During the overshoot, fly no higher than route echelon. The more airspeed and (or) angle-off, the more turn radius required to solve the problem. In addition, a co-speed overshoot due to an angular problem may not require flying outside of lead's turn circle. Instead, flying to lead's low six o'clock may allow enough forward visibility to safely align fuselages and stop the overshoot. When range, LOS, and angle-off are under control, return to the inside of lead's turn, reestablish an appropriate aspect angle, and complete the rejoin to fingertip.

6.22.4. Three- and Four-Ship Overshoot Deconfliction. As with a rejoin, ***maintain a minimum of 500 feet spacing from the preceding aircraft until it has completed the overshoot and is stabilized. If overshooting, preceding aircraft will inform the other wingmen with a radio call.***

6.23. Breakout:

6.23.1. When in close proximity to another aircraft, ***break out when (1) directed by lead, (2) unable to maintain sight of lead, (3) unable to rejoin or remain in formation without crossing under or in front of lead, or (4) any time your presence constitutes a hazard to the formation.*** In UFT and PIT, breakouts are also flown as training exercises.

6.23.2. For breakouts, predictability is critical for all players. Lead should continue the current maneuver with the current power setting if possible. However, if the wingman is in sight, maneuvering to obtain, increase, or guarantee separation may also be appropriate or necessary. In all cases, lead should try to stay visual and be directive with the wingman as appropriate (for example, "Pistol 2 rollout, visual is your right 2 o'clock high", "rejoin, left turning", etc.).

6.23.3. Wingmen should clear in the direction of the breakout, maneuver to ensure safe separation from other aircraft, and notify lead, if required, when conditions permit. Once safe separation is assured, the wingman may rollout to attempt to regain the visual. After the wingman calls visual, lead will direct him or her to the desired formation.

6.23.4. Control inputs can vary anywhere from maximum rate stick deflection to avoid collision to a small check turn away. If breaking out due to a lost-sight situation, the wingman will break away from lead's last known position or direction of turn, using power and speed brakes as required.

6.23.5. A breakout exercise may be accomplished from a variety of positions and situations. Lead will direct the breakout with a radio call, after which the wingman will simultaneously execute an appropriate breakout maneuver and make a radio call ("Pistol 2's breaking out"). The culmination of the exercise is the same as described in **paragraph 6.23.3**.

6.24. Close Trail:

6.24.1. Lead initiates close trail with a radio call from fingertip, echelon, or route. Lead will wait for wing's "in" call ("Iron 2's in") before maneuvering and then use any combination of turns, modified lazy eights, or barrel rolls.

6.24.2. ***Over-the-top maneuvering in close trail is not permitted*** . Be smooth and predictable, avoid rapid or inconsistent roll rates, and maintain a minimum of 1 G at all times. ***Use no more than 4 Gs for close trail***.

6.24.3. Wing will acknowledge the call to go close trail ("2"), maneuver to the close trail position, and call in. Proper position is one to two aircraft lengths behind lead and just below lead's jet wash.

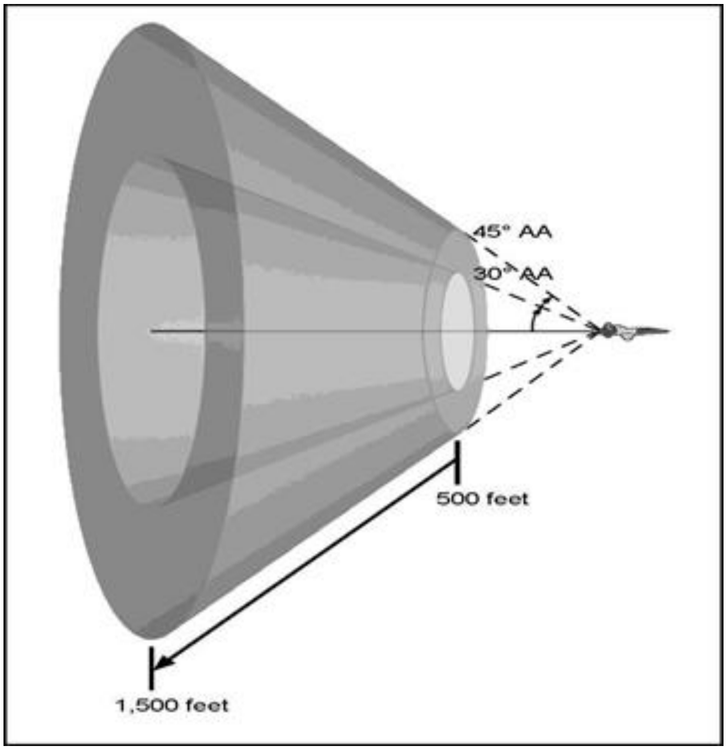
6.24.4. In the correct vertical position, you should see space between the forward edge of lead's horizontal stabilator and the trailing edge of lead's wing. To prevent encountering jet wash, never fly higher than a position where that space disappears.

6.24.5. For a fore/aft separation reference, use the relationship between the tips of lead's horizontal stabilator and the ailerons. At approximately one ship length, the stabilator tips are lined up with the outer two-thirds of the ailerons. At approximately two ship lengths, the tips are lined up with the mid- point of the ailerons. When aft of the proper position or when lead is turning at higher G loadings, you may need to fly slightly inside the turn to gain or maintain position.

6.24.6. End the exercise by directing wing to the desired formation using visual signal or radio call ("Buddy 2, reform left"). If returning to fingertip, lead must avoid any significant power changes until wing is in position.

6.25. Fighting Wing. Fighting wing is flown as a maneuverable two-ship administrative formation. Lead directs number 2 to the fighting wing position with a radio call ("Iron 21, go fighting wing"). There is no requirement to call in position. The fighting wing position is a cone 30- to 45-degree AA from lead, 500 to 1,500 feet aft (Figure 6.10). As wing, you can approximate the forward limit of the cone (45-degree AA) by aligning lead's wingtip with the middle of the aft canopy and the aft limit (30-degree AA) by aligning lead's wingtip with the nose of the aircraft. Another technique to estimate AA is to compare the apparent wingspan to the apparent length of the T-38. At 30-degrees AA, the apparent length equals the apparent wingspan. At 45- degrees AA, the apparent length is approximately 30 percent longer than the apparent wingspan. For estimating range, at 500 feet you should easily read lead's tail number; at 1,000 feet, you should easily see, but not be able to read, lead's tail number; and you should be able to discern two separate tail pipes. The wingman should strive to maintain a position inside lead's turn circle using lead and lag, resulting in lower power settings**.** ***Lead will not fly aerobatic maneuvers with the wingman in fighting wing. Wingmen may use rolling maneuvers to maintain or regain position IAW AFI 11-2T-38 V3 restrictions.***

Figure 6.10. Fighting Wing Cone.



Section 6C—Tactical Formation

6.26. Types and Principles:

6.26.1. “Tactical” is an umbrella term covering several formations characterized by increased separation between the members of the flight. Tactical is the primary formation flown when employing fighter aircraft. It is designed to optimize weapons and radar employment while improving visual lookout and increased maneuverability. A variety of tactical formations may be flown depending on the number of aircraft in the formation and the type of employment desired. For two-ships, tactical formations include line abreast and wedge. Both may be referred to on the radio by their separate names; however, if the lead refers to “tactical”, this is understood to mean “line abreast”. For four ships, tactical formations include fluid four, wall, and box or offset box. Regardless of the variety of tactical formation being flown, some basic principles apply:

6.26.1.1. ***The lead aircraft is primarily responsible for maneuvering the formation, and the wingman is primarily responsible for maintaining formation position and deconfliction*** .

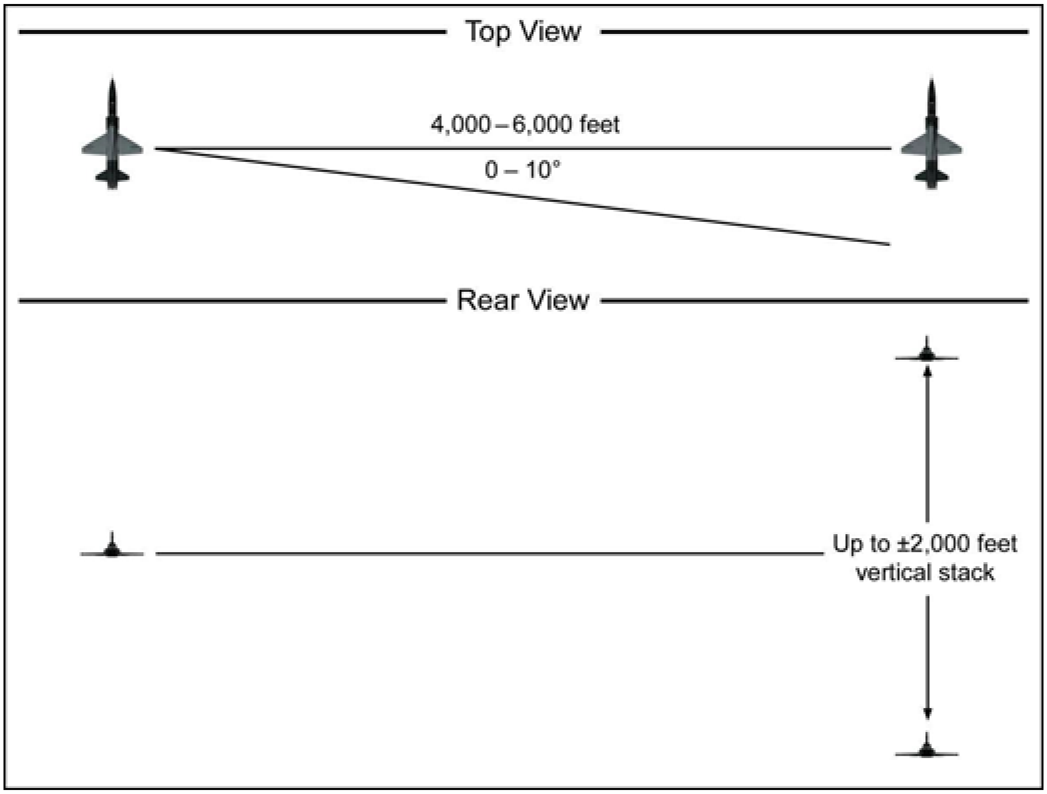
6.26.1.2. The wingman’s primary reference for heading and airspeed is lead. The lead must cross-check the wingmen to monitor their positions, and the wingmen must back lead up by monitoring area orientation, navigation, etc.

6.26.1.3. Both aircraft share equal responsibility with visual lookout—one of the primary reasons for flying tactical line abreast. Line abreast provides excellent lookout capability. Scan patterns should include the extremes above and below the horizon. See **Figure 6.11**.

6.26.1.4. Tactical formations are normally flown at airspeeds near corner velocity (350 to 400 KCAS), but other airspeeds may be flown. Unless otherwise briefed, the standard airspeed for tactical formation is 350 KCAS at or above 10,000 feet MSL, and 300 KCAS below 10,000 feet MSL.

6.27. Line Abreast (LAB). The parameters of this tactical formation are 4,000 to 6,000 feet spacing, line abreast to 10 degrees aft, and a vertical separation (stack) of up to 2,000 feet (**Figure 6.11**).

Figure 6.11. Tactical Line Abreast.



6.27.1. To enter tactical formation, lead may use a radio call (e.g., "Rocky 51, tactical left side") or a visual signal by porpoising the aircraft. The wingman then moves out into the tactical position (see **paragraph 6.27.5**), clearing the flightpath while moving out. In order, the priorities for correcting formation position are fore and aft positioning, lateral separation, and vertical stack. Strive to fly line abreast—no further aft than 10 degrees—by varying power and trading altitude for airspeed (or vice versa) to make fore or aft corrections.

6.27.2. Visual references for lateral spacing include the following (Can change based on environmentals):

6.27.2.1. At 4,000 feet, the VHF antenna (shark fin) disappears, the underside rotating beacon disappears, and (or) the canopy bow disappears, and both canopies blend into one.

6.27.2.2. At 6,000 feet, the "L" formed by the aft edge of the vertical stabilizer and the burner cans start to disappear (depending on environmental visibility). Also, depending on the environmentals, the canopy disappears or blends into the aircraft.

6.27.2.3. Outside 6,000 feet, most details disappear, and the aircraft loses most of its definition.

6.27.3. The A/A TACAN is a useful tool to calibrate your eyes. Use 0.7 NM for an approximate 4,000 foot range and 1.0 NM for a 6,000 foot range. If local procedures allow, TCAS symbology on a 2.5 NM EHSI can be used to help calibrate your eyes. Six thousand feet is approximately at the outer CDI dot, and 4,000 feet is midway between the two dots.

6.27.4. Strive for a vertical stack of approximately 500-1000 feet, but remember that stack is a tertiary priority and should only be increased as proficiency allows. When restricted by airspace or weather, wingmen may be required to fly co-altitude with lead. Depending on assigned altitude, level stack may place the other aircraft significantly above the horizon. Wider spacing (6,000 feet vs 4,000 feet) and higher altitude result in lead aircraft being higher above the horizon than closer spacing and lower altitude. TCAS and/or verifying altitude between aircraft should be cross-checked to confirm level stack when necessary.

6.27.5. When given the signal to go to tactical LAB, the wingman will:

6.27.5.1. Clear the flightpath in the direction of the turn away from lead.

6.27.5.2. Turn away from lead to achieve 4,000 to 6,000 feet of lateral spacing. One technique for achieving the appropriate spacing is cross-checking lead's heading then check away while monitoring lead ensuring zero forward/aft LOS rate.

6.27.5.3. Roll back to lead's approximate heading when approaching 4,000 to 6,000 feet of lateral spacing, and set power and airspeed to match lead's current parameters.

6.27.5.4. Assess LOS and adjust power, airspeed, and heading as required to zero out LOS and HCA.

6.28. Tactical Turns.

6.28.1. Radio Calls and Visual Signals. Accomplish small course corrections through check turns. Accomplish turns of more than 30 degrees by means of a delayed turn (45 through 90 degrees), in-place turn, or fluid turn. For reversing the flightpath 180 degrees, use a hook turn or cross turn. Radio calls or visual signals may be used to signal tactical turns. For example, the radio call for a delayed 90-degree turn would be "Buzz 21, 90 left/right." No radio response is required from the wingmen. All tactical turns except a cross turn or hook turn into the wingman may be signaled with a wing flash in the direction of the turn. Lead should show the wingman the full planform (approximately 90 degrees of bank) when signaling a tactical turn to avoid confusion with minor course corrections (usually use 30 degrees of bank or less). If needed to attract the wingman's attention, a "zipper" (double-click on the radio microphone switch) may be combined with the visual signal. Wingmen should assume a delayed 90-degree turn until signaled otherwise.

6.28.2. Turn Contract. As turns are executed, all aircraft need to adhere to a "contract" during the turn to help ensure turn rate and radii are similar. Use the following parameters for contract turns: MIL power, G to hold altitude and airspeed (at medium altitude, approximately 0.35 AOA or just short of the light tickle). The second aircraft to turn (the aircraft getting turned into) may vary power, altitude, and G as necessary to finish the turn in position on the appropriate side of the formation. At lower altitudes, all aircraft must remain aware of terrain elevation, descent rate, and bank angle.

6.28.3. Deconfliction. The wingman takes the initiative to deconflict from lead. If the wingman is stacked high or low, he or she should maintain that stack when commencing the turn especially if he or she is the first to turn. If there was no stack at turn initiation, there may be no need for further deconfliction due to built-in lateral spacing. The wingman should always be clearing their flight path and "telegraph" their intentions for vertical deconfliction when necessary by positively maneuvering the jet. Both lead and wing are ultimately responsible for flightpath deconfliction and must clear during turns and take appropriate evasive action if required. If the formation is assigned a hard altitude (no altitude block), the wingman should climb or descend slightly for deconfliction if necessary—both aircraft must adhere to the cleared altitude.

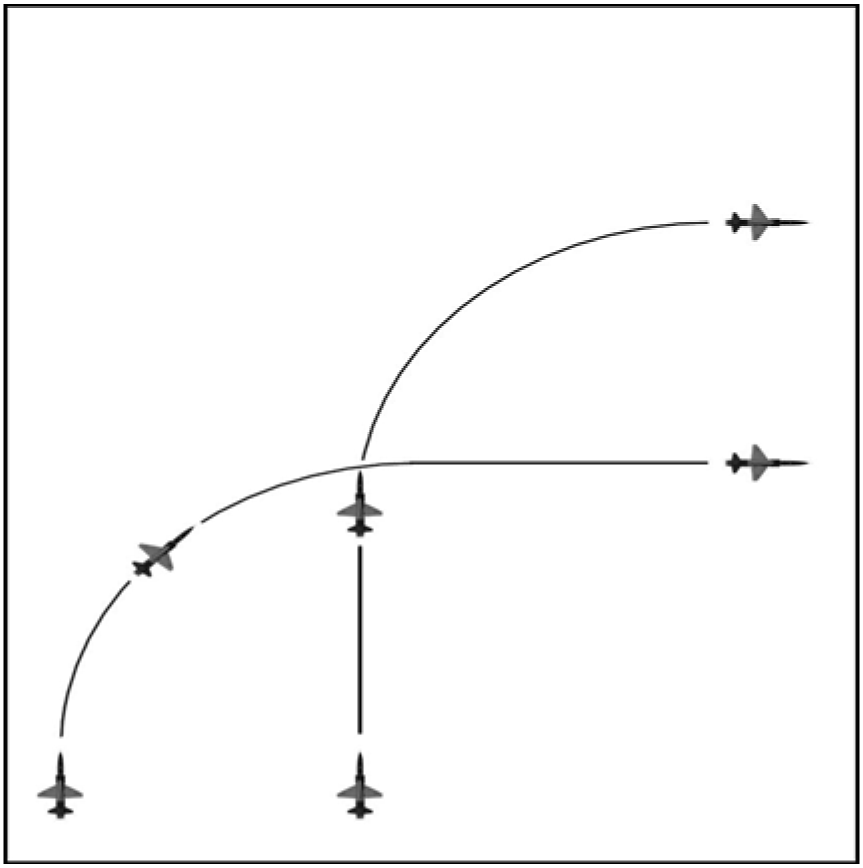
6.29. Delayed 90-Degree Turns:

6.29.1. Turns Into the Wingman (**Figure 6.12**):

6.29.1.1. If the turn is called over the radio, lead begins the contract turn immediately after the call. Otherwise, lead's contract turn into the wingman signals the turn. As lead begins the turn, the wingman continues straight ahead and deconflicts the turn by maintaining or obtaining sufficient vertical clearance. The wingman should use this opportunity to clear lead's new 6 o'clock position.

6.29.1.2. The wingman initiates a 90-degree contract turn to rollout in tactical on the other side of lead. The timing for starting this turn occurs just prior to observing a rapid increase in lead's LOS. If the wingman is in position, the increase in LOS will occur after lead has turned approximately 45 degrees or just prior to looking down lead's intakes. This reference does not work if wing is out of position. If out of position, the wingman must vary the timing and G loading of the turn, based on lead's LOS, to finish the turn in position. Generally, when inside 6,000 feet or aft of LAB, the wingman should begin the turn earlier than looking down lead's intakes. When outside 6,000 feet or forward of LAB, the wingman should begin the turn after looking down the intakes. Also, when in proper position, at lower altitudes, the wingman should begin the turn later. The opposite is true at higher altitudes.

Figure 6.12. Delayed 90-Degree Turn.

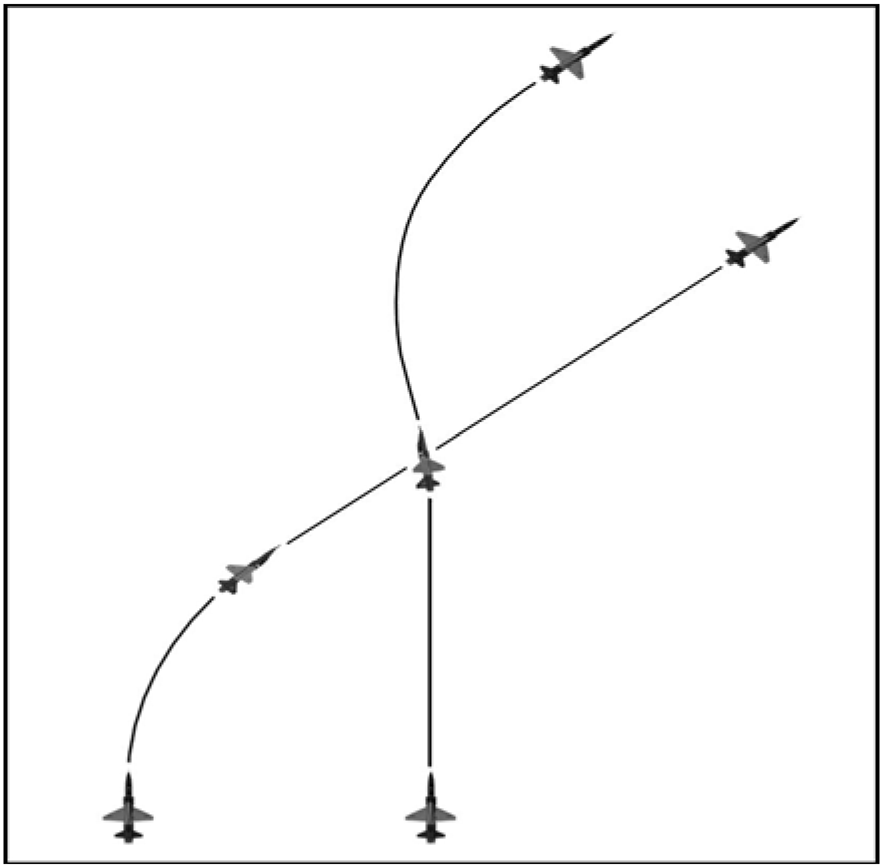


6.29.2. Turns Away From the Wingman. This is a mirror image of the 90-degree turn into the wingman. When directed, the wingman begins a contract turn into lead and uses all available references to rollout after approximately 90 degrees of turn. Lead delays and then performs a contract turn to rollout on the desired heading. After lead rolls out, the wingman is responsible for obtaining the correct position.

6.30. Delayed 45-Degree Turns:

6.30.1. Turns Into the Wingman (**Figure 6.13**). If the turn is called over the radio, lead begins the turn immediately after the call. Otherwise lead's turn into the wingman signals the turn. As lead begins the turn, the wingman continues straight ahead and deconflicts by maintaining or obtaining sufficient vertical clearance. The wingman should use this opportunity to clear leads new 6 o'clock position. When lead rolls out, the wingman maneuvers as required to achieve a tactical position on the other side of lead's aircraft by either delaying the turn until lead crosses the 6 o'clock position or by immediately maneuvering to the other side of lead. Either way, the aircraft being turned into should pass in front of (not over top or underneath) the other aircraft for the geometry to work out. During comm.-out turns, lead must ensure the rollout occurs before the wingman begins a delayed 90-degree turn. If the wingman begins a 90-degree turn, lead should use the radio to achieve the desired turn ("Vega 2, rollout").

Figure 6.13. Delayed 45-Degree Turn.



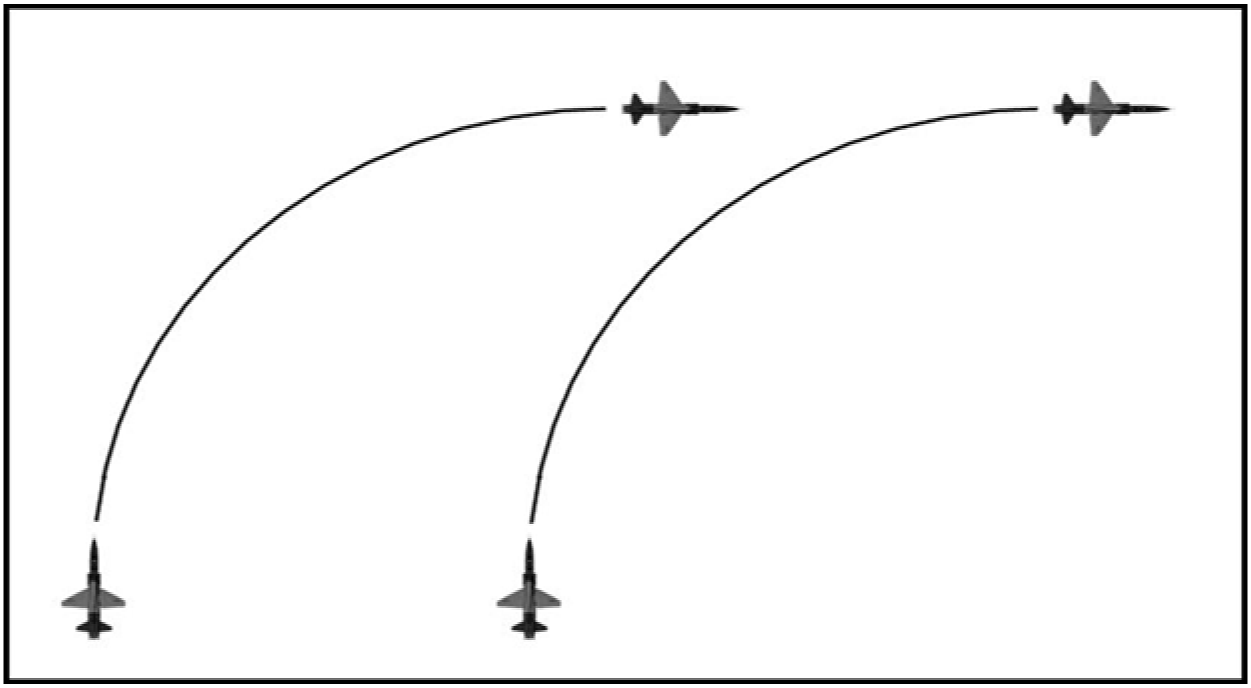
6.30.2. Turns Away From the Wingman**.** This is a mirror image of the 45o turn into the wingman. The wingman begins a contract turn into lead when directed. Lead signals the wingman's rollout by beginning a contract turn into the wingman. Lead will maneuver to the opposite side of the wingman in LAB position. After lead rolls out, the wingman is responsible for obtaining the correct position.

6.31. Other Tactical Turn Variations. For turns greater than approximately 60 degrees, lead will generally direct a delayed 90-degree turn. For turns between approximately 30 to 60 degrees, lead will generally direct a delayed 45-degree turn. For turns approximately 30 degrees or less, lead will call a check turn and turn to the desired heading. In all cases, the wingman's responsibility is to maintain or regain position.

6.31.1. Check Turns. The check turn is usually no more than 30 degrees of turn. Initiate the turn by transmitting "Felon 31, check (degrees to turn) left/right." Normally, both aircraft execute simultaneous contract turns, and the wingman remains on the same side.

6.31.2. In-Place Turns (**Figure 6.14**). Use an in-place turn when you want the formation to maneuver in one direction at the same time. To initiate, lead transmits "Felon 31, in-place 90 left/right." Both aircraft turn at the same time—in the same direction—using contract turns. If executed from line abreast tactical, a 90-degree turn will put the formation in trail at whatever lateral spacing existed prior to the turn.

Figure 6.14. In-Place 90-Degree Turn.

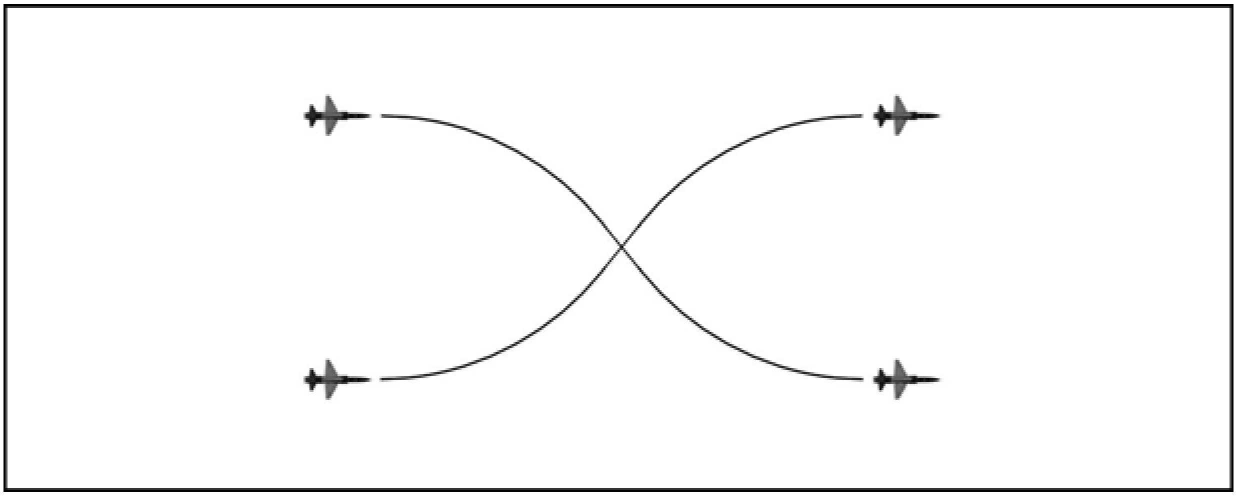


6.32. Shackle:

6.32.1. Use a shackle (**Figure 6.15**) to put the wingman on the opposite side or to allow him or her to regain the correct position. Initiate the shackle by transmitting, "Mega 21, shackle." Both aircraft turn toward each other, with the wingman ensuring vertical deconfliction. Generally, the wingman rolls out with lead to minimize fore-aft LOS. Both aircraft reverse the turn after crossing flight paths. Lead rolls out on the original or desired heading, and the wingman assumes proper tactical position.

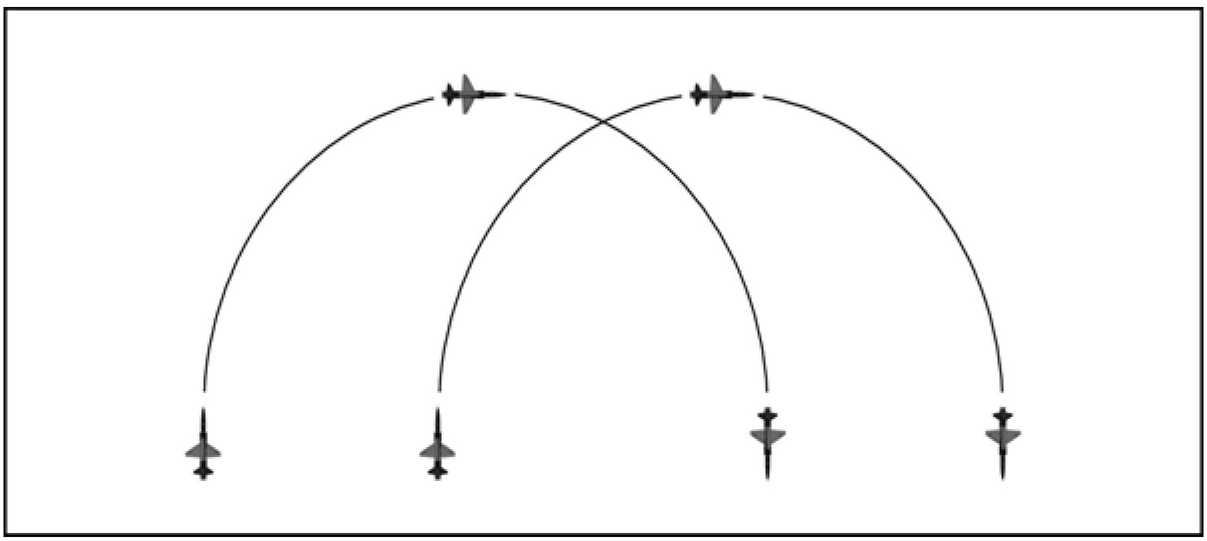
6.32.2. If not starting out line abreast, aircraft will maneuver during the shackle as appropriate for the situation. If the shackle is to allow the wingman to correct a forward position, the correct lead maneuver may be to continue straight ahead. If the wingman is behind at the start of a shackle, he or she may use less bank angle and (or) angle-off to regain the proper position. If the wingman is ahead at the start of a shackle, he or she may use more bank angle or angle-off to regain the proper position.

Figure 6.15. Shackle.



6.33. Hook Turns. During a hook turn (**Figure 6.16**), the formation turns 180 degrees with both aircraft performing a contract turn at the same time in the same direction.

Figure 6.16. Hook Turn.



6.33.1. Hook Turns Into the Wingman. A hook turn into the wingman must be called over the radio ("Bam 41, hook right/left"). During the first half of the turn, lead is responsible for keeping the wingman in sight. Shortly after halfway through the turn, the wingman should acquire, maintain sight of, and fly off of lead. If the turn is flown properly, the wingman will roll out in the correct position. If not, he or she must maneuver to obtain the proper spacing and position.

6.33.2. Hook Turns Away From the Wingman. Hook turns away from the wingman may be signaled visually by a wing flash or called over the radio. If initiated with a wing flash, lead will begin turning when the wingman begins his or her turn. Lead's immediate turn tells the wingman this is not a 90- degree turn. For the first half of the turn, the wingman should match lead's turn rate, be at 0 degrees AA and HCA at the 90-degree point of the turn. Shortly after halfway through the turn, lead should acquire and maintain sight of the wingman. If this turn is flown properly, the wingman will be in position at the completion of the turn. If not, wing must maneuver to obtain the proper spacing and position.

6.34. Cross Turns:

6.34.1. Cross turns (**Figure 6.17**) are another 180-degree reversal option. Both aircraft make a contract turn into each other with altitude split for flightpath deconfliction. Two basic challenges occur during the turn: (1) reacquiring visual contact with the other aircraft, and (2) too much lateral spacing caused by the T-38's turn performance.

Figure 6.17. Cross Turn.

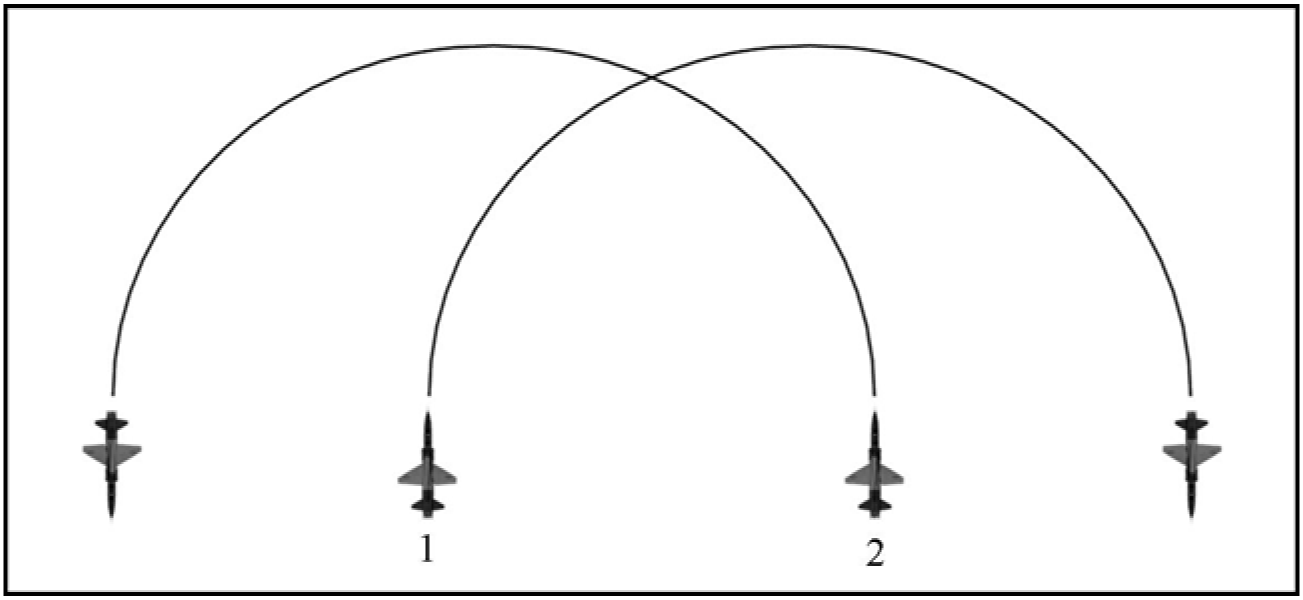
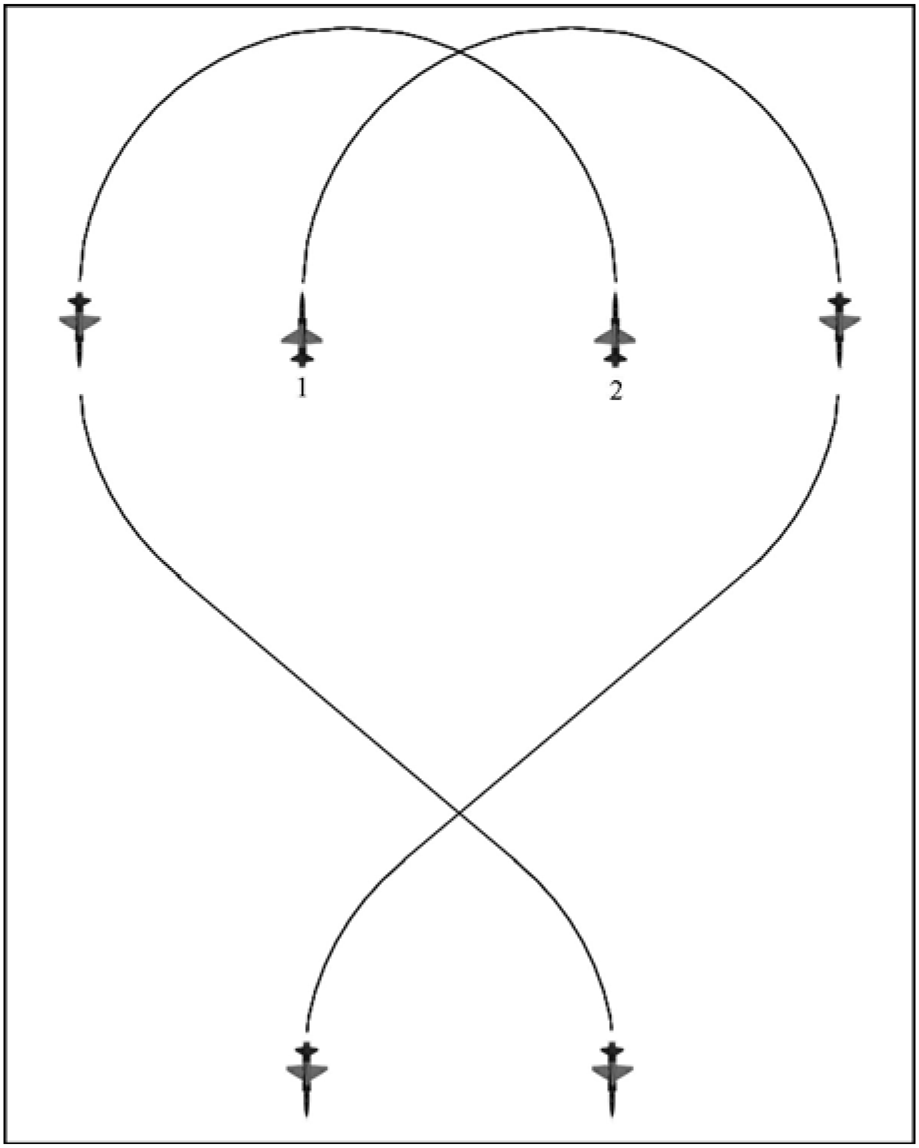


Figure 6.18. Cross Turn with Shackle.



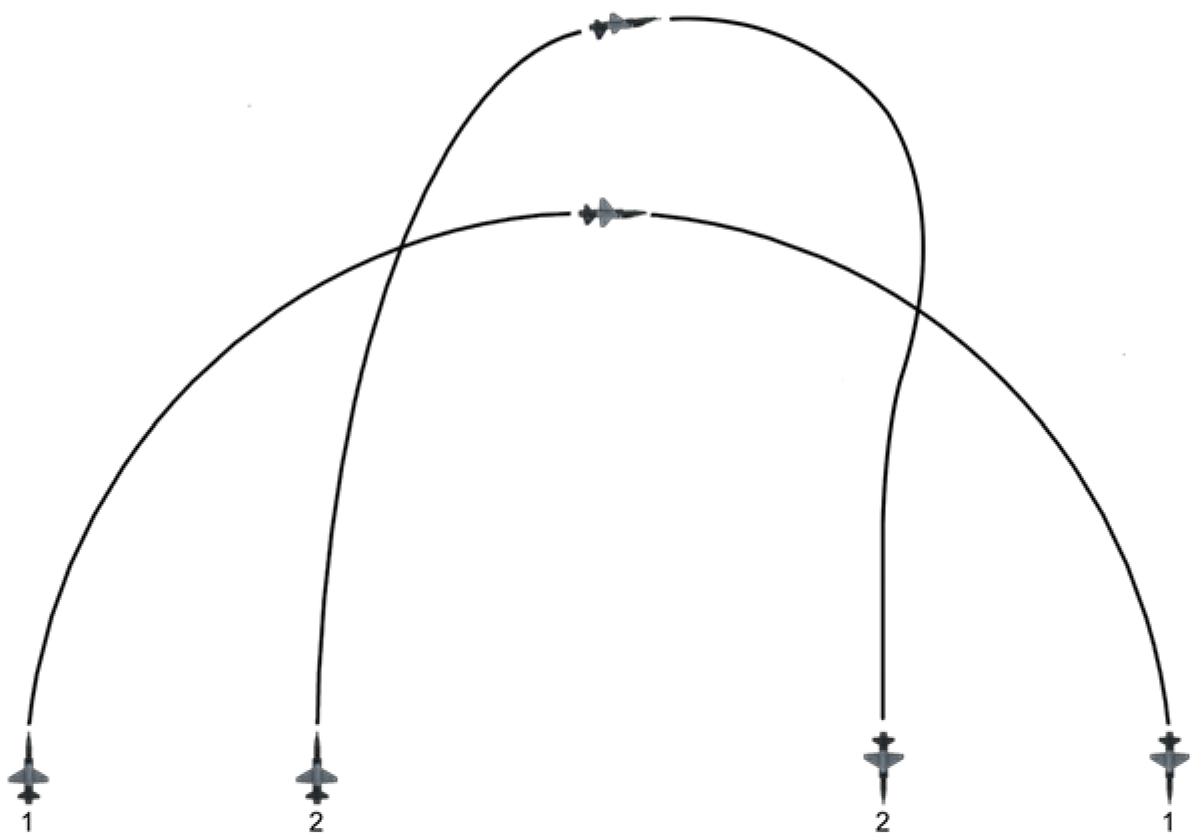
6.34.2. Cross turns will be executed on a verbal command from lead ("Buzz 31, cross turn"). Immediately, both aircraft will commence a contract turn toward each other. Aircraft should cross after 60 to 90 degrees of turn and continue their turn through 180 degrees. The flight is now on a reciprocal heading, but, because of the large turn radius, the lateral separation will be wide (2 to 3 NM) if the original spacing was correct. Conversely, if the wingman's spacing was initially wide, a cross turn should result in reduced lateral separation.

6.34.3. As quickly as possible after turning through 90 degrees, each pilot must reacquire and maintain visual with the other aircraft. If the other aircraft is not reacquired during the second half of the turn, call "blind" immediately upon rollout.

6.34.3.1. Following completion of the turn, unless briefed otherwise, wing will begin to correct back to the tactical LAB position. To correct lateral spacing, lead may direct a shackle (**Figure 6.18**). If the wingman is blind but lead is visual, lead may direct a shackle while maintaining altitude separation and attempting to talk the wingman's eyes back onto lead. Due to the distance between aircraft, it is possible for neither pilot to regain sight after the cross turn. If this happens, both will maintain the reciprocal heading until directed otherwise by lead. Lead will ensure altitude separation.

6.35. Fluid and Easy Turns. These turns are used to maneuver a formation when there is very little G or excess thrust available (heavy weight and (or) higher altitudes). Lead will normally make heading changes in 90-degree increments, using approximately 45 degrees of bank and maintaining airspeed and altitude. Also, fluid turns are almost purely "geometry" turns with power settings normally constant. If a 180-degree turn is required, combine the techniques for two 90-degree turns (**Figure 6.19**). The radio call for a fluid turn is "Snake 21, fluid left/right." No acknowledgement is required. For an easy turn, lead will use approximately 60 degrees of bank and pitch to hold airspeed. Military power is usually the constant setting for easy turns.

Figure 6.19. Fluid Turn.



6.35.1. Turns Into the Wingman. As a wingman, start a turn in the same direction as lead (**Figure 6.19**). Whatever bank angle technique is used, you must continuously monitor lead's position. You should normally have 20 to 30 degrees of turn completed as lead passes your 6 o'clock position, depending on lead's position at the start of the turn. For example, if you were behind when the turn started, you may want to delay the cross. If you were ahead, you may want to cross earlier. Once you have crossed lead's flightpath, adjust the turn to assume proper spacing and lower the nose to pick up airspeed, if necessary.

6.35.2. Turns Away From the Wingman. The wingman is immediately behind at the onset of the turn. He or she will roll into more bank than lead and lower the nose slightly to gain airspeed in order to move to the inside of the turn behind lead. As the turn progresses, the wingman will reduce the bank to attain proper lateral spacing and trade excess airspeed for altitude as he or she approaches the LAB position.

6.36. Belly Check. A Belly Check is a momentary reduction in bank performed by a turning fighter to clear the area hidden by the fuselage of the aircraft. This is typically a maneuver performed in formation, often by the inside fighter of a formation executing a tactical hook turn.

6.37. High Altitude Tactical. When flying tactical formation above FL 250, the following techniques are useful:

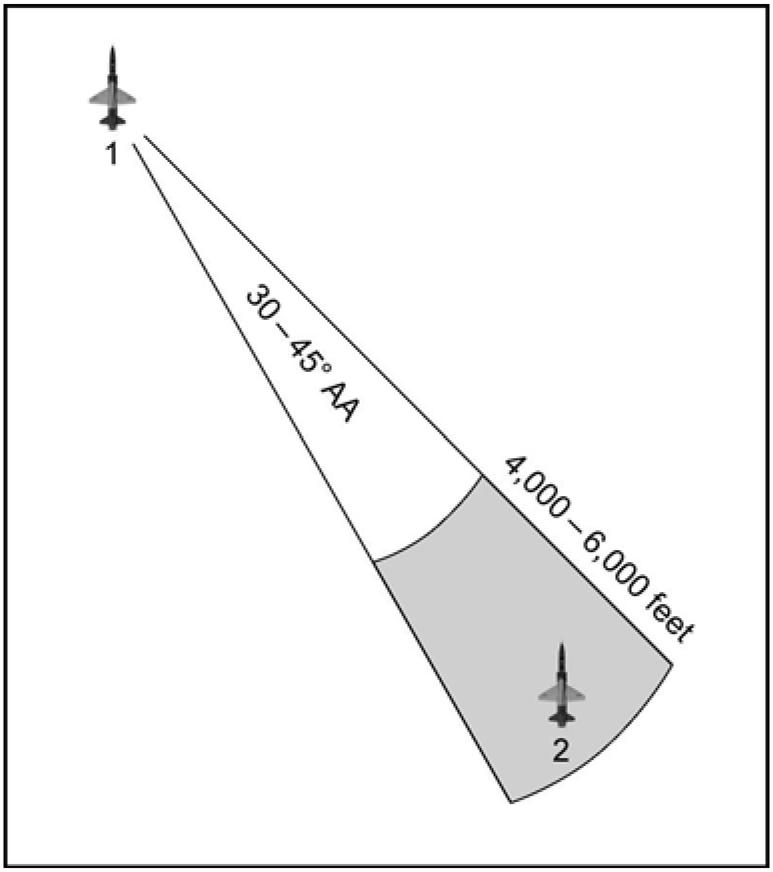
6.37.1. Normally, 0.85 to 0.9 IMN is a good airspeed range because it provides both maneuverability and good fuel flow at the higher altitudes. These speeds also provide excess power and, except with extremely cold outside air temperatures, will maintain operations within the engine envelope.

6.37.2. Do not plan formation flights above FL 350. However, if you must operate above FL 350, use 0.9 IMN or slightly higher as the base airspeed.

6.37.3. Energy conservation is a priority at the higher altitudes because less thrust is available. Additionally, throttle movements must be small to avoid compressor stalls. The basic maneuvering remains the same, but due to the increased emphasis on energy conservation, buffet should be avoided as much as possible. To accomplish this and to compensate for the higher true airspeed, use earlier lead turns than at lower altitudes. For example, during a delayed 90-degree turn into, start the turn as the other aircraft turns through approximately 30 degrees of turn (rather than 45 degrees). This should be apparent with the LOS concept discussed in paragraph 6.30.1.2.

6.38. Wedge. Lead might direct the wingman to wedge formation (**Figure 6.20**) when terrain, tactics, etc., require an increased degree of flight maneuverability. The wedge position is primarily used in the low altitude environment. Turns do not need to be called. The wingman will maneuver as required to maintain position. Wedge is defined as a position 30 to 45 degrees off lead's 6 o'clock (30 to 45 degrees AA) at a range of 4,000 to 6,000 feet. The wingman will not fly lower than lead in the low altitude environment and will fly no higher than approximately 500 feet above lead unless required to fly higher due to obstacle clearance during turns. Maneuver as required to maintain position to include crossing lead's 6 o'clock if required.

Figure 6.20. Wedge Formation.



6.39. Tactical Rejoins:

6.39.1. Overview. All rejoins will be initiated with a wing rock or radio call. ***Wingmen will acknowledge all radio calls to rejoin***. The standard platform for lead is 350 KCAS, 45 degrees of bank, and level flight. Different parameters may be briefed or called on the radio. Proficient wingmen will not require a radio call when different parameters are used. Wingmen should strive to maintain closure during the rejoin.

6.39.2. **Straight-Ahead Tactical Rejoin.** As the wingman, rejoin to the side occupied when given the radio call or visual signal. Unlike a normal straight-ahead rejoin from a trail position, a tactical straight- ahead rejoin begins from a lateral spread. The mechanics of flying this maneuver will vary based on position when initiating the rejoin. If necessary, maneuver vertically or laterally to gain turning room. The following should provide a systematic approach on which to build from a LAB starting position:

6.39.2.1. If there is stack greater than 500 feet, attempt to work toward a stack-level position.

6.39.2.2. Roll and pull the aircraft to put lead slightly forward of the LAB picture on the canopy.

6.39.2.3. Use power as required to remain slightly aft of LAB (90 degree AA off of lead). The aimpoint should be toward the close trail position (slightly aft/low).

6.39.2.4. As range closes, lead will begin to move further forward on the canopy if nothing is done with HCA. As this begins to occur, start taking out some of the HCA (align fuselages) to maintain lead in a slightly forward of LAB position on the canopy.

6.39.2.5. Once in a route position, finish the rejoin to fingertip.

6.39.2.6. Tactical Straight-Ahead Rejoin Overshoot. Wing should not cross to the other side of lead (cross lead's six). If closure is so excessive requiring wing to lose visual of lead, consider this a breakout. Select idle and speed brakes (if required) as soon as excess overtake is recognized. Guard against turning back into lead while looking over your shoulder. A small, controllable 3/9 line overshoot is easily managed and can still result in an efficient rejoin. Retract the speed brakes and increase power just prior to achieving co-airspeed (stagnant LOS) to prevent falling aft.

6.39.3. Turning Rejoin into the Wingman. Even before lead turns, wing has excessive AA and must use lag pursuit. Maneuvering to lag helps solve the initial AA problem but introduces excessive HCA as the wing approaches lead's turn circle. An initial move in the vertical is therefore required to build maneuvering room (turning room) to solve HCA. As wing approaches leads turn circle, available turning room must be used to zero out HCA or to align fuselages. With wing slightly outside lead's turn circle, wing should see a slight forward LOS rate across the canopy out of lead. At this point, wing should modulate power to stabilize lead's LOS on the canopy to cross lead's six o'clock at the desired range while remaining clear of his or her jet wash. Wing establishes himself or herself back inside the turn at the desired airspeed and AA. From here, wing follows the turning rejoin procedures described in **paragraph 6.21.3** to the briefed or directed position. As proficiency increases, wing can work to cross lead's six o'clock at closer ranges to a point to where wing performs a maneuver similar to the second half of a crossunder to the inside of lead's turn.

6.39.4. Turning Rejoin Away From the Wingman. As soon as lead turns, wing is outside the turn and needs to maneuver to the inside of the turn with lead pursuit. Use caution because an excessive amount of lead pursuit may result in excessive AA, HCA, and (or) closure. Cross lead's six o'clock while remaining clear of the jet wash and assess your energy (airspeed, altitude differential and, angular closure). Once inside lead's turn, wing follows the turning rejoin procedures described in **paragraph 6.21.3** to the briefed or directed position.

6.40. Extended Trail (ET) Exercise:

6.40.1. Desired Learning Objectives (DLO). The ET exercise is an initial building block that introduces some of the concepts and skills required in future short-range basic fighter maneuvers (BFM). The ET exercise allows pilots to practice the use of pursuit curves and dynamic maneuvering in relation to another aircraft. The DLOs of ET are as follows:

6.40.1.1. To practice recognizing and solving problems of range, closure, AA, HCA, angle-off and turning room from short-range, simulated "offensive" position behind a cooperative aircraft flying a scripted training profile.

6.40.1.2. Perch Setup**:**

6.40.1.2.1. The DLOs of the Perch Setup are as follows:

6.40.1.2.1.1. To practice maintaining briefed training parameters.

6.40.1.2.1.2. To introduce and practice a composite cross-check, administrative setup, termination and reset for advanced maneuvering.

6.40.1.2.1.3. To practice maneuvering to, entering, and maintaining the ET cone from a position outside the cone.

6.40.1.2.1.4. To introduce and practice the application of A/A training rules (TR).

6.40.2. The ET Cone. The cone for ET is defined as 30°- 45° AA on lead and between 1,000 to 3,000 feet range. Wing evaluates position in the ET cone using visual references and stadiametric range estimation.

6.40.2.1. Visual References. For wing, the reference for the 30° and 45° AA is the same as for the fighting wing position. For visual ranging:

6.40.2.1.1. At 1,000 feet, you should easily see, but not be able to read, lead's tail number, and you should be able to discern two separate tailpipes.

6.40.2.1.2. At 3,000 feet, you can just start to make out detail on the airplane. You should be able to recognize detail such as a clearly visible canopy and canopy bows, shoulders (intakes), distinct lines where the wings and tail meet the fuselage, a distinct horizontal stabilizer, and clear lines where the colors on the paint scheme change.

6.40.2.1.3. At 4,000 feet, just outside the ET cone, is where the VHF antenna ("shark fin") disappears; however, this reference requires the belly of lead's aircraft to be in view.

6.40.2.2. Stadiametric Range Estimation. Stadiametric ranging (described in Attachment 2) is another technique that can be used to determine ranges. The HUD symbology provides known size references for stadiametric ranging. "Mil-sizing" lead relative to HUD symbols does not require lead to be within the HUD field of view (FOV). You should be able to visualize references to HUD symbols with lead outside the HUD FOV. You must maintain a vigilant composite cross-check, especially outside of the cockpit and with lead's aircraft, in order to recognize cues that could result in a potential deconfliction problem with lead.

6.40.3. Responsibilities. All pilots must fulfill the following common responsibilities during the ET Exercise and Perch Setup:

6.40.3.1. Collision Avoidance. As with other formation maneuvering, each pilot has the responsibility to take whatever action is necessary to avoid a collision. Because of the dynamic nature of the extended trail position, the problems of collision avoidance are compounded and require uncompromising flight discipline. All flight members must be vigilant with regard to clearing their flightpath and recognizing and avoiding the prebriefed minimum range limitation (often called "the bubble").

6.40.3.2. Fuel Awareness. Because the Extended Trail Exercise and Perch Setups generally involve higher power settings for longer periods of time, all pilots must continually monitor their fuel state to prevent overflying joker/bingo. Lead should call for an ops check prior to each engagement. ***Ops checks accomplished between engagements or after the last engagement will include G's.***

6.40.4. Exercise Setups. There are two ways to send wingmen to the ET position—the ET Exercise and the Perch Setup (which is accomplished from tactical line abreast).

6.40.4.1. ET Exercise. Accomplish the entry ET exercise from any basic formation position. Lead initiates the entry with a radio call ("Colt 21, go extended trail") and wing acknowledges ("2"). Lead maneuvers by pulling away from wing with a military power and moderate G turn. Wing maneuvers as required to attain the ET cone. Once wing calls in ("Colt 2's in"), Lead begins the maneuvering phase as defined in **paragraph 6.40.5.2**.

6.40.4.1.1. Terminate and flight rejoins. Until lead directs a rejoin or another formation position, wing will attain and maintain the ET position.

6.40.4.2. Perch Setup. The purpose of the perch Setup is to introduce and practice a composite cross-check, the administrative setups, terminations, and resets used in follow-on training such as BFM. The need for standardization of the setup is critical for reconstruction, debriefing, and assessment of DLOs. Each exercise will be preceded by a descriptive preparatory radio call by lead ("Colt 21, next exercise is Perch Setup, (Offensive/Defensive) for #2.") followed by an acknowledgement from wing ("2"). Each pilot must strive to be in the correct starting position and must not call ready until the prebriefed starting parameters have been achieved.

6.40.4.2.1. Avionics. Lead and wing should select the A/A master mode after lead's descriptive preparatory radio call ("Colt 21, next exercise is Perch Setup, (Offensive/Defensive) for 2."). ***The A/A master mode will be selected prior to the respective ready call.***

6.40.4.2.2. Lead. **Starting parameters for lead are: altitude as briefed, 350 ±10 KCAS.**

6.40.4.2.2.1. Once lead has achieved the correct starting parameters, lead calls ready ("Colt 1's ready.").

6.40.4.2.2.2. After wing's ready call, lead directs a check turn ("Colt 21, check 45 left/right"), and turns 45 degrees away from wing for a defensive setup and into wing for an offensive setup.

6.40.4.2.2.3. As the offender achieves near pure pursuit, the defender reverses the turn direction while monitoring the offender, modulates power as required to arrive at the fight's on at **315 ±10 KCAS**, and adjusts bank angle and Gs to set the desired AA of 30 to 45° while maintaining altitude. Decelerating from 350 KCAS and arriving at the fight's on with less than 320 KCAS and 30° to 40° of AA is a challenge. During the initial check turn, modulate power and pull to the buffet to bleed down to 320-330 KCAS; then allow the jet to decelerate the last 5 to 15 knots with throttle modulation after you have reversed your turn and have set the desired AA. For a level flight, 40° AA reference, the defender should look over their shoulder and see the offender slightly above the horizon (roughly a beer can on its side) and roughly a beer can in front of the rear canopy bow. The offender's lateral position can also be visualized above the wingtip (in relation to the aircraft) or just outside the wingtip (in relation to the horizon). See **Figure 6.21**. A common error during this phase is not to maintain level flight while looking over your shoulder. Maintain a composite cross-check.

6.40.4.2.2.4. Once the offender calls “fight’s on,” the defender begins the briefed exercise phase (as defined below).

Figure 6.21. 40-Degree AA Picture from Lead Aircraft Front Cockpit.

6.40.4.2.3. Wing. **Starting parameters for wing is stack level with lead, 350±15 KCAS, and 1.1±0.1 line abreast.**

6.40.4.2.3.1. If starting parameters have been achieved, wing calls ready (“Colt 2’s ready.”) after lead’s ready call. If starting parameters have not been achieved, wing responds with the appropriate alibi (for example, “Colt 2, standby airspeed”), and then calls ready (“Colt 2’s ready.”) when within starting parameters.

6.40.4.2.3.2. At the check 45 left/right call, the offender executes a contract tactical turn to near pure pursuit (lead under the HUD gun cross) and then modulates power to arrive at the fight’s on **350 ±10 KCAS** while maintaining near pure pursuit.

6.40.4.2.3.3. As range decreases, the offender calls down ranges until 3,000 feet (“6,000…5,000…4,000). The offender estimates ranges using visual references or the stadiametric ranging technique discussed in **Attachment 2**.

6.40.4.2.3.4. At 3,000 feet, the offender initiates the Reposition Phase with a fight’s on call (“Colt 21, fight’s on.”).

6.40.4.2.3.5. Floor. 10,000 ft MSL (or as briefed for local airspace requirements).

6.40.5. Reposition Phase. The purpose of the reposition phase is to allow the offender to solve range, aspect, closure, and HCA issues against a stable platform. Always enter the reposition phase from a perch entry.

6.40.5.1. Defensive aircraft. The defender's specific DLOs are to maintain visual and practice the composite cross-check. The execution entails setting power at 550 EGT and performing a continuous 2 to 3 G descending turn maintaining **315 ±10 KCAS**. The defender will maintain SA on the offender's position, even when he temporarily transits the defender's six o'clock. The defender should develop a cross-check that allows him or her to maintain visual, awareness of his own ship's energy state, and the floor.

6.40.5.2. Offensive aircraft. The offender's specific DLOs are to position the aircraft at the inside of the defender's turn circle and near the forward edge of the ET cone (1,200-1,500 feet and 40-45 AA), execute a controlled reposition **(*do not penetrate the 500 ft bubble*)**, and then continue to maneuver as required to maintain the ET cone. The offender must constantly assess visual cues to assess and control range, AA, HCA, and closure. Based on these cues, the offender must select the appropriate pursuit curve to reposition the aircraft as required. Reference **Figure 6.32** **Lead Reposition** and **Figure 6.31** **Lag Reposition**.

6.40.5.3. Flight lead may brief to omit the reposition phase described above. In this case, the defender begins the maneuvering phase after offender's "Fight's on" call.

6.40.6. Maneuvering Phase. The purpose of the maneuvering phase is to allow the offender to explore the ET cone against a dynamic platform and develop a crosscheck for both aircraft to ensure SA is maintained: floor awareness, MOA boundaries, remain visual and manage energy. From the basic formation entry or after the reposition phase from the perch entry, the offender will initiate the maneuvering phase with an "in" call ("Colt 2's in"). Unless briefed otherwise, the defender's power setting will be 550 degrees EGT and the offender's power setting will be 600 degrees EGT for the maneuvering phase. The flight lead may brief different power settings for defender and offender to achieve a DLO. As wing gains proficiency, the flight lead may brief to allow offender the ability to modulate power, which will transfer positively to follow-on training.

6.40.6.1. Defender. Defender's specific DLOs are to challenge offender with aerobatic maneuvering while maintaining visual or SA on offender's position, maintaining area orientation, and properly managing energy. Defender is not required to perform maneuvers to the precise parameters used in transition flying and should vary the attitudes and airspeeds as necessary for effective training, area orientation, visual lookout, and smoothness.

6.40.6.1.1. Consider offender's skill level while maneuvering to prevent exceeding his or her capabilities, but continue to challenge offender with ET position problems to solve. High-G maneuvers are of little value if offender is unable to maintain the proper position. Remain constantly aware of G forces because offender is often exceeding lead's G level to maintain or regain position.

6.40.6.1.2. Limit ET maneuvering to turns, lazy eights, barrel rolls, cloverleafs, loops, and Cuban eights. ***Do not perform abrupt turn reversals; that is, turns in one***

direction followed by a rapid, unanticipated roll into a turn in the opposite direction. Defender will not maneuver in an attempt to force offender to overshoot.

6.40.6.1.3. Defender should attempt to keep offender in sight but shouldn't sacrifice flightpath deconfliction to do so. Defender must, however, keep SA of offender's position at all times.

6.40.6.2. Offender. Offender's specific DLOs are to maintain the ET cone without stabilizing on defender's turn circle. The correct ET position is rarely static in relation to defender. Offender should strive to maintain a position from which defender can stay visual. Avoid defender's jetwash by avoiding defender's POM when crossing defender's turn circle. If you determine you will pass through defender's jetwash, unload the aircraft to approximately 1 G to prevent an asymmetric over-G.

6.40.6.3. Lost Sight. If the defender loses visual he will transmit "C/S (1/2) no joy" and continue to maneuver predictable (continue the turn). The offender will immediately transmit "continue" if he is visual on the defender. If the offender is not visual, a "knock-it-off" will be transmitted and the offender will lag the defender's last known position. Reference **paragraph 6.62.6**.

6.40.7. Terminate. Terminate the ET exercise according to AFI 11-2T-38, Volume 3. Normally the defensive aircraft will terminate at a time that is advantageous for the flight in regards to MOA boundaries and profile management, however the offensive aircraft may terminate for DLO attainment.

Colt 1 or 2: "Colt 21 Terminate"

Colt 1: "Colt 1 Terminate"

Colt 2: "Colt 2 Terminate"

6.40.7.1. Post-terminate Maneuvering:

6.40.7.1.1. Reset to Tactical. From a perch entry, the normal post-terminate maneuver is a reset to tactical with a climb back to the starting altitude block.

6.40.7.1.2. Offensive: After the terminate call, the offender will lag the defender, roll wings level and set military power. The defender will set military power, initially continue their turn but then time their turn reversal to place the offender into a line abreast position. The timing of defender's turn reversal will be relative to wing's position at the terminate call. Once line abreast, both aircraft will attain and maintain 350 KCAS in the most energy efficient manner available, then set pitch as required to return to the starting altitude block. The wingman will make necessary correction to attain and maintain 4,000 to 6,000 feet spacing.

6.40.7.1.3. After the termination drill, a reference heading by lead may be used to increase wing's SA, but is optional. Wing must continuously assess lead and maneuver to stay in position.

6.40.7.1.4. Flight leads may utilize "easy" turns as needed for MOA awareness. An "easy" turn is flown by modulating G in order to maintain a slight climb while executing tactical turns (45/90/180).

6.40.7.1.5. The reset to tactical is dynamic due to the likely differences in airspeed between defender and offender. Minimal time should be spent heads-down in the cockpit for both aircraft while the formation resets to tactical. After achieving line abreast, lead must maintain a vigilant lookout for wing as wing solves tactical formation problems.

6.40.7.2. Avionics. ***Lead and wing will return to the NAV master mode after the terminate drill and no later than completion of the post-terminate ops check.***

6.40.8. Energy Conservation. Energy conservation is very important for wing. Buffet in a high-performance airplane signifies a loss of energy. When encountering buffet, wing must decide what is more important, nose track or energy. If nose track is more important, wing may have to sacrifice airspeed by pulling in the buffet.

6.40.9. Training Rules. AFI 11-2T-38, Volume 3 provides training rules, including KIO, terminate, and minimum weather requirements. In addition:

6.40.9.1. ***Extended trail is limited to two-ship formations.***

6.40.9.2. When one or more flight members lose visual contact, follow the loss of visual contact procedures in AFI 11-2T-38, Volume 3.

6.41. Four-Ship Tactical. A four-ship formation combines the basic elements of two-ship tactical formation into a formation of four aircraft. The three four-ship tactical formations include fluid four, wall, and box or offset box. With the increased number of aircraft in the formation, all flight members must maintain visual awareness or SA on the other aircraft to ensure deconfliction. Strictly adhering to the contract turns and aggressively maintaining proper formation position will greatly reduce the risk of a midair collision. Although each pilot maintains an obligation to maintain visual on all aircraft, there are situations that may prevent this. The priority for wingmen is to maintain visual with, and maneuver in relation to, their element lead. Number 3's priority is to maintain visual with number 1, while fulfilling element lead responsibilities for number 4. Any time these priorities cannot be fulfilled, the flight must be informed with a timely "blind" call. It is imperative for all flight members to fly the aircraft efficiently and to try to anticipate what lead may do next.6.41.1. Fluid Four. This is a simple and efficient formation for medium and high altitudes.6.41.1.1. Element leads (numbers 1 and 3) fly two-ship tactical LAB. Numbers 2 and 4 fly a fighting wing position off their respective element lead, striving to maintain a position on the outside of the formation when not maneuvering (**Figure 6.21**). Tactical turns (**Figure 6.22**) are made between number 1 and number 3, the same as in two-ship tactical. Element leads can make it easier for their respective wingmen to stay in position by pausing momentarily between banking up and beginning to pull during turns, allowing the wingman to begin to maneuver for the turn.

Figure 6.22. Fluid Four Formation.

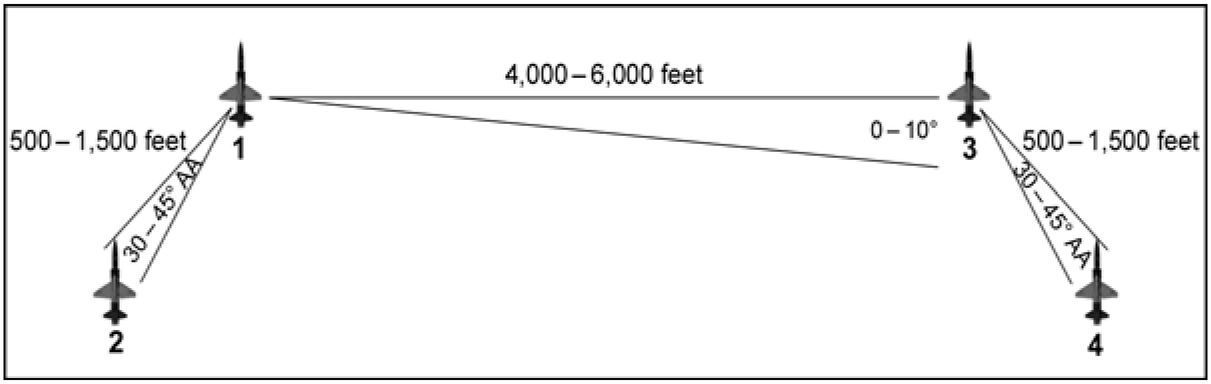
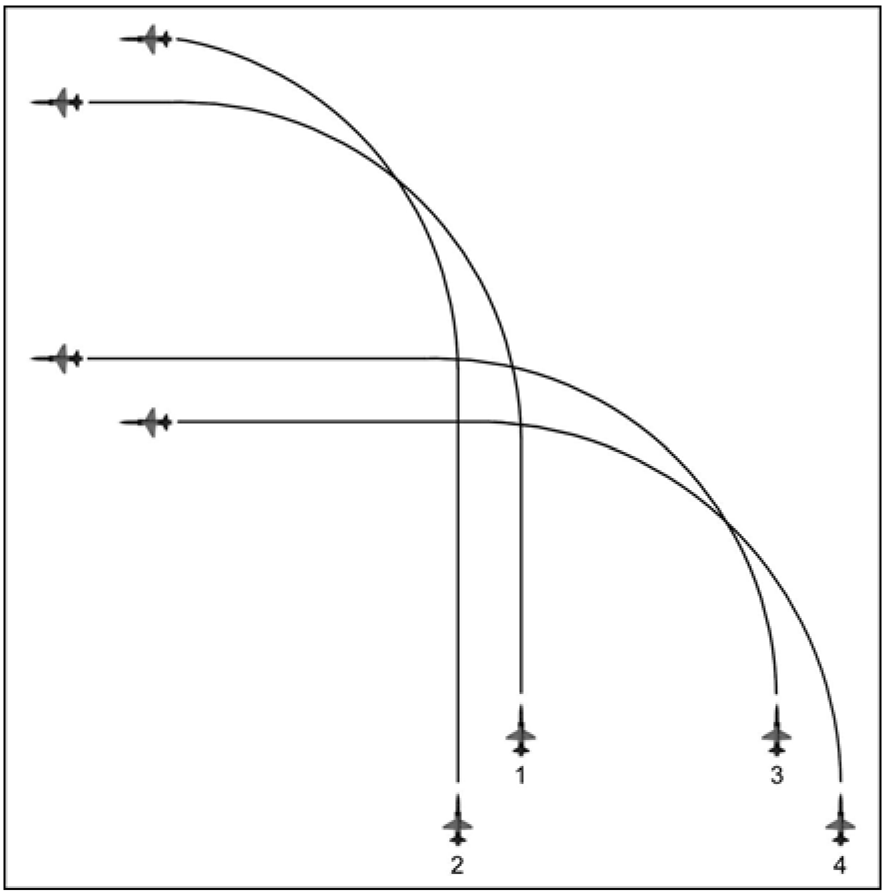


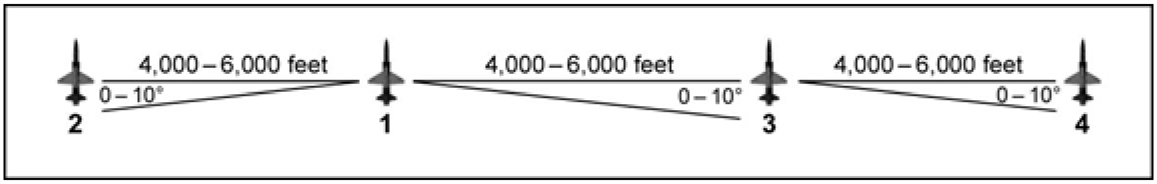
Figure 6.23. Fluid Four Turns.



6.41.1. The highest potential for conflict occurs during the turns as the elements cross during the turn. If the element leads are LAB at the start of the turn, this conflict is minimized but still exists if the wingman in the element being turned into has fallen back. If the element being turned into is aft of LAB at the start of the turn, there is a much higher opportunity for conflict, and all players must use extreme caution. Vertical stack between the element leads minimizes the opportunity for conflicts. However, the primary means of deconfliction is visual lookout. If the wingman of the high element is below his or her element lead, use extra caution to ensure deconfliction between wingmen during turns.

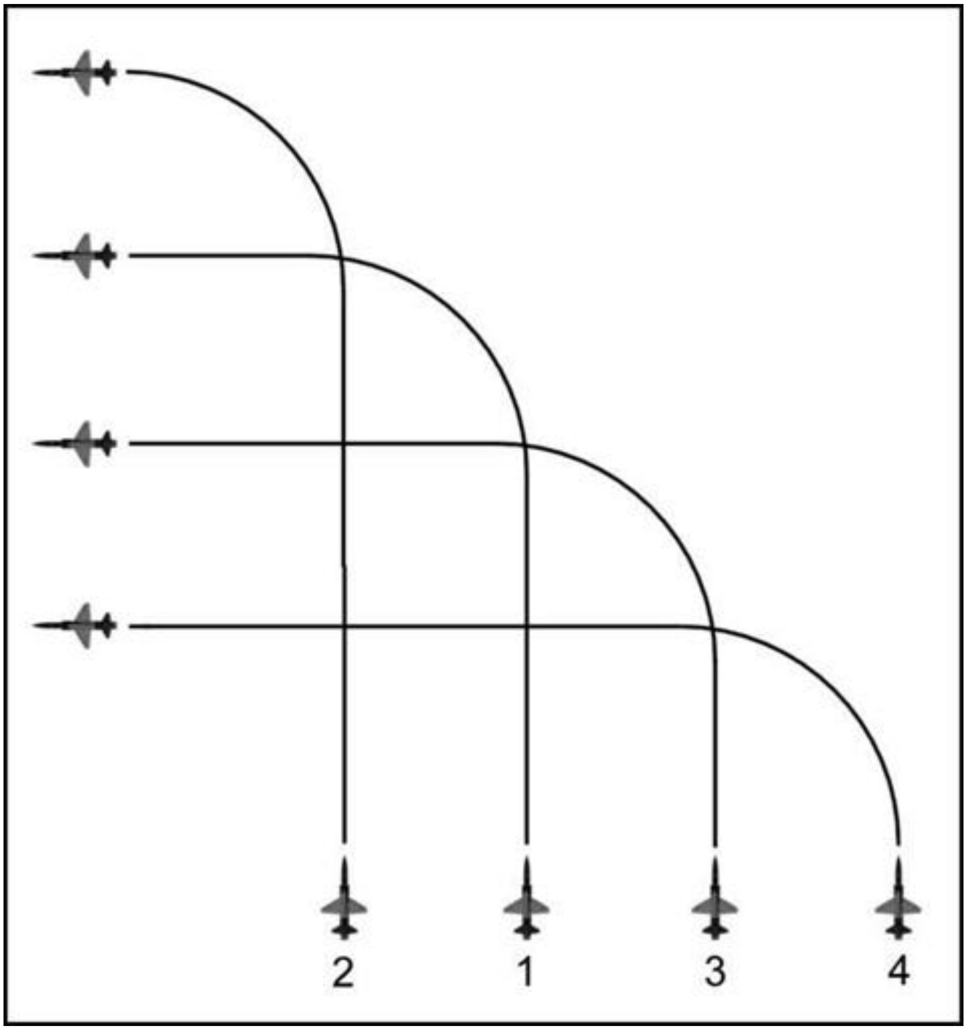
6.41.2. **Four-Ship Wall Formation.** The four-ship wall formation (**Figure 6.24**) is four aircraft in LAB tactical formation. To establish the formation, all flight members fly LAB tactical formation as described in paragraph 6.28. The wingmen (numbers 2 and 4) fly LAB off their respective element leads. The flight lead should brief specific stack guidance for all wingmen.

Figure 6.24. Four-Ship Wall Formation.



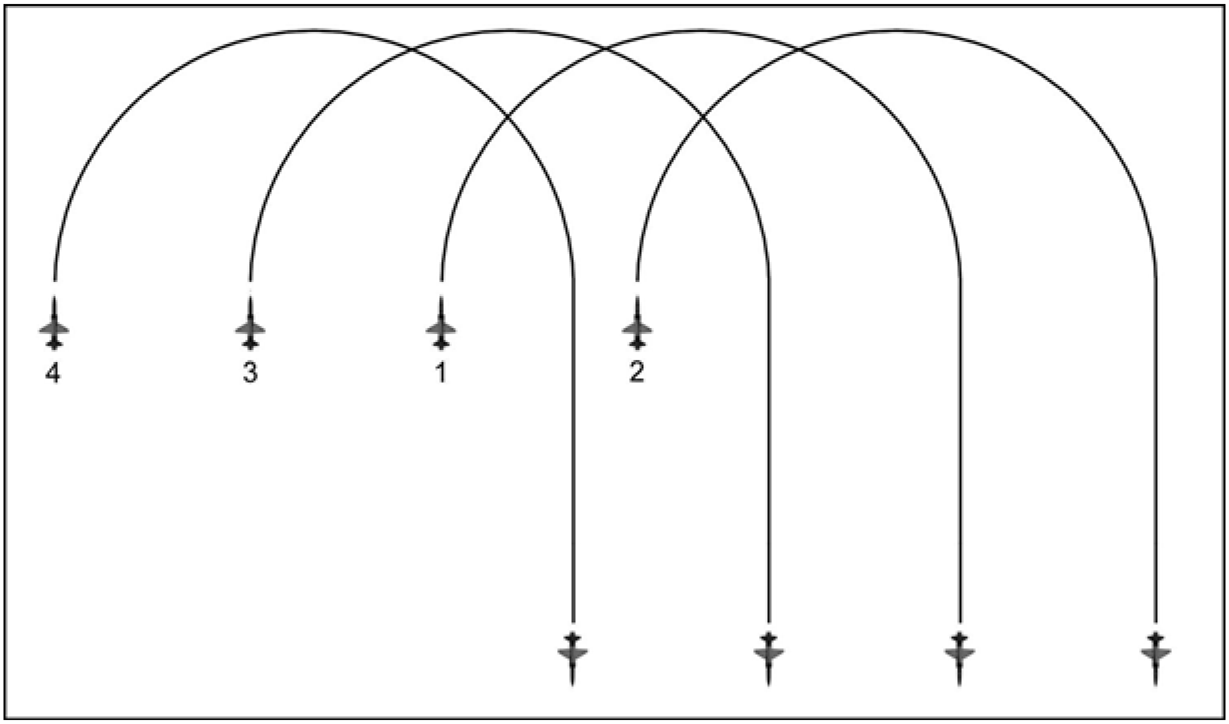
6.41.2.1. Four-Ship Wall Delayed Turns. Delayed turns (**Figure 6.25**) are executed similar to a two-ship tactical. Turns are directed by a radio call or visual signal. If lead gives the signal requiring number 4 to be the first to turn, number 3 should repeat the signal down to number 4. The wingman on the outside of the turn (the first aircraft to turn) flies a contract 90-degree turn, and each pilot in succession uses two- ship tactical references and adjustments to execute a contract 90-degree turn. As number 1 completes the turn, wingmen maneuver to regain position. As in fluid four, conflicts are minimized if all aircraft are relatively LAB at the start of the turn. If aircraft have fallen back, the potential for conflicts is increased.

Figure 6.25. Four-Ship Wall Delayed Turn.



6.41.2.2. Four-Ship Wall Hook Turns. Hook turns are tactical turns executed by all members of the formation simultaneously, resulting in LAB formation heading approximately 180 degrees from the original heading (**Figure 6.26**)**.** Potential for conflicts during hook turns increases if flight members do not fly the contract turn causing the turn radii to be different.

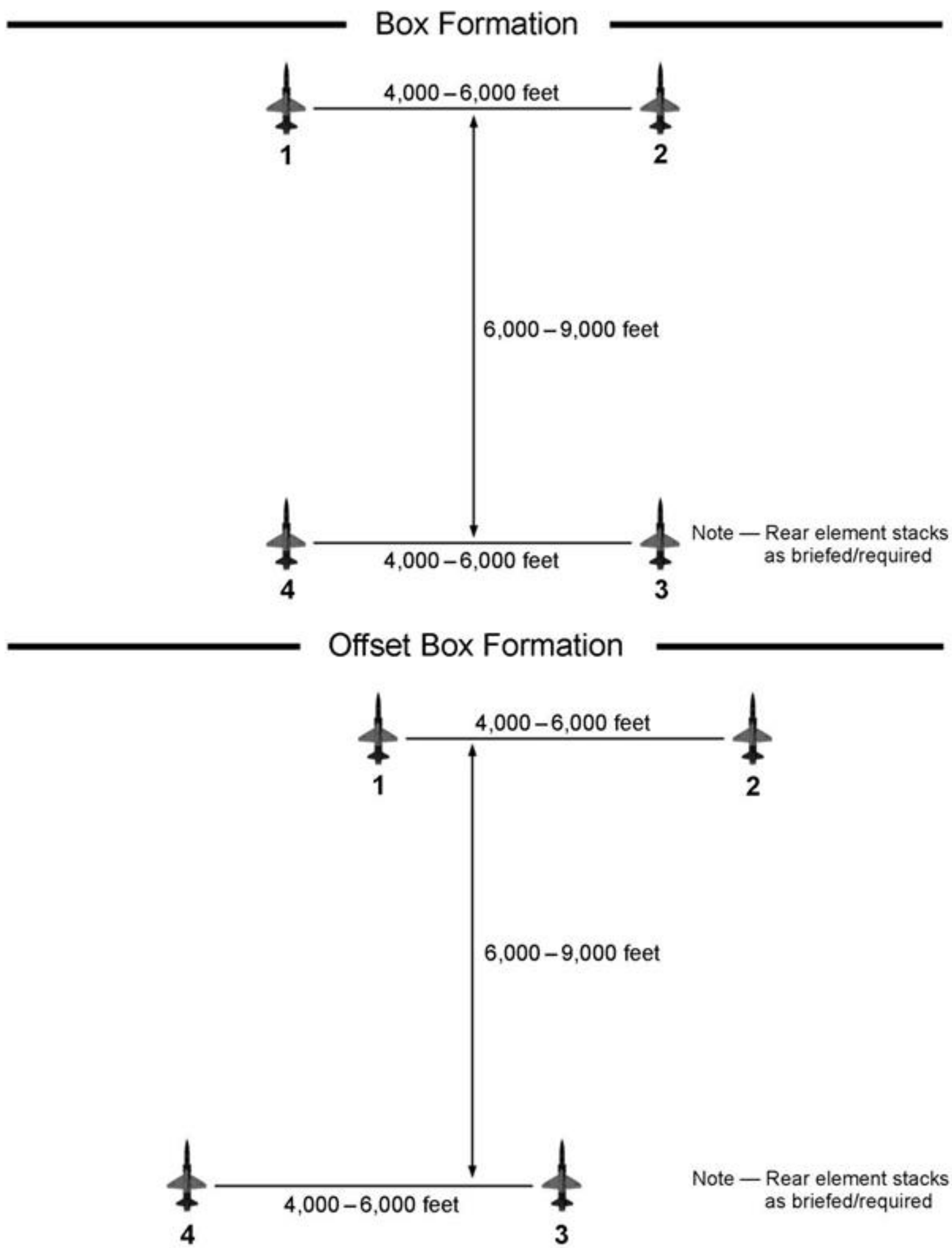
Figure 6.26. Four-Ship Wall Hook Turn.



6.41.3. **Four-Ship Box or Offset Box Formations:**

6.41.3.1. Overview. Four-ship box formation is essentially two elements flying LAB tactical, separated in trail by 6,000 to 9,000 feet (**Figure 6.27**). Unless specifically briefed by the flight lead or directed by their respective element lead, number 2 and number 4 can be on either side of their element lead, and the side number 2 and number 4 are on is irrelevant to one another. The rear element can fly directly in trail of the lead element (box) or offset the lead element (offset box) at lead's discretion. Generally, by flying offset box, it is easier for all flight members to maintain visual contact with one another. In offset box formation, number 3 may elect to place number 4 in the slot. The rear element should normally stack either high or low from the lead element, based on the brief or environmental conditions, unless required to maintain level because of weather or airspace restrictions. Cockpit visibility from the lead aircraft and the small size of the T-38 can make visibility between the front and rear elements a challenge because of environmental conditions and range. This may result in the rear element padlocking on the lead element to maintain visual.

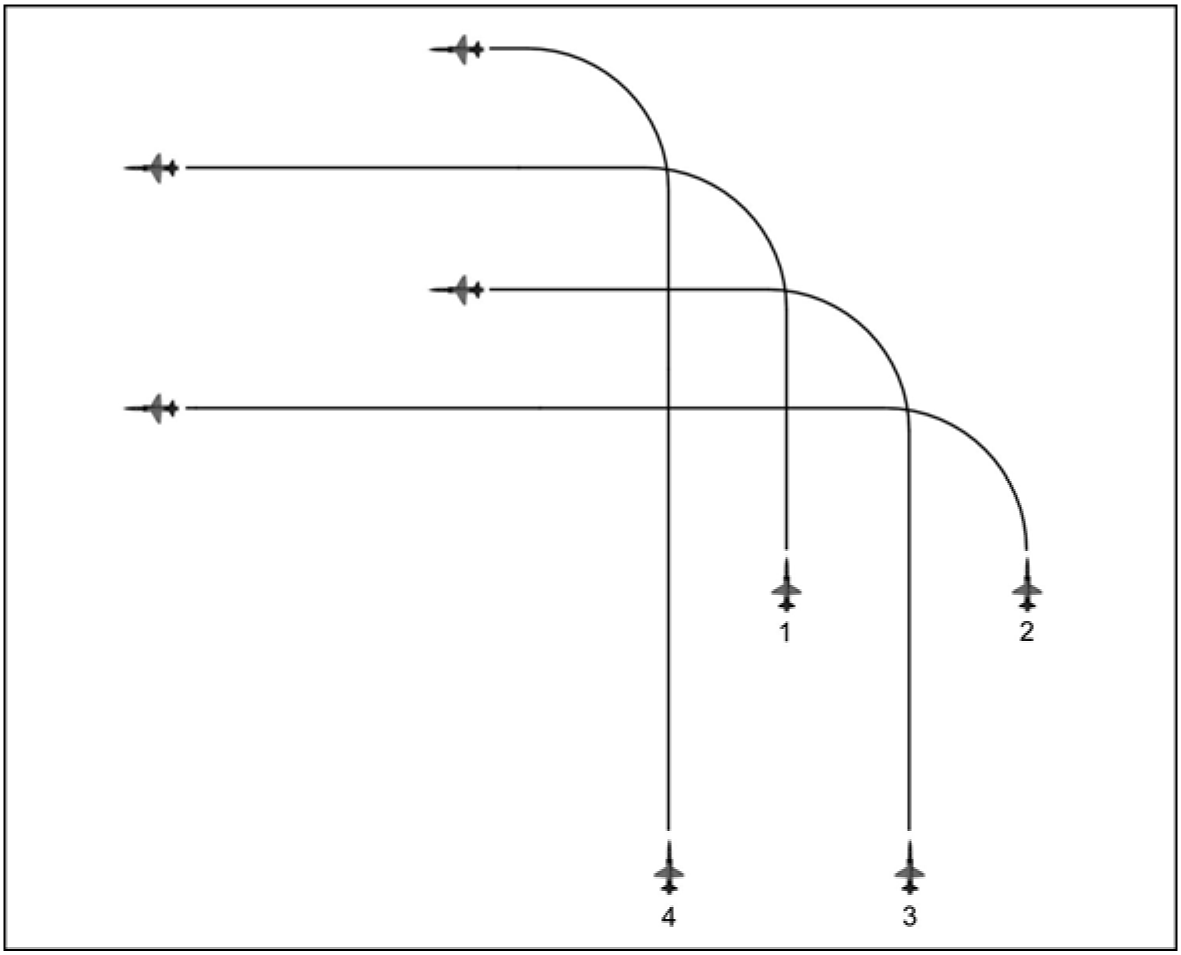
Figure 6.27. Box and Offset Box Formation.



6.41.3.2. Box Formation Turns:

6.41.3.2.1. Lead directs delayed 45- and 90-degree turns with a radio call or visual signal. Each element performs a standard delayed turn (**Figure 6.28**), with number 3 turning the trailing element to finish in the correct position relative to the leading element.

Figure 6.28. Offset Box Formation Delayed Turn.

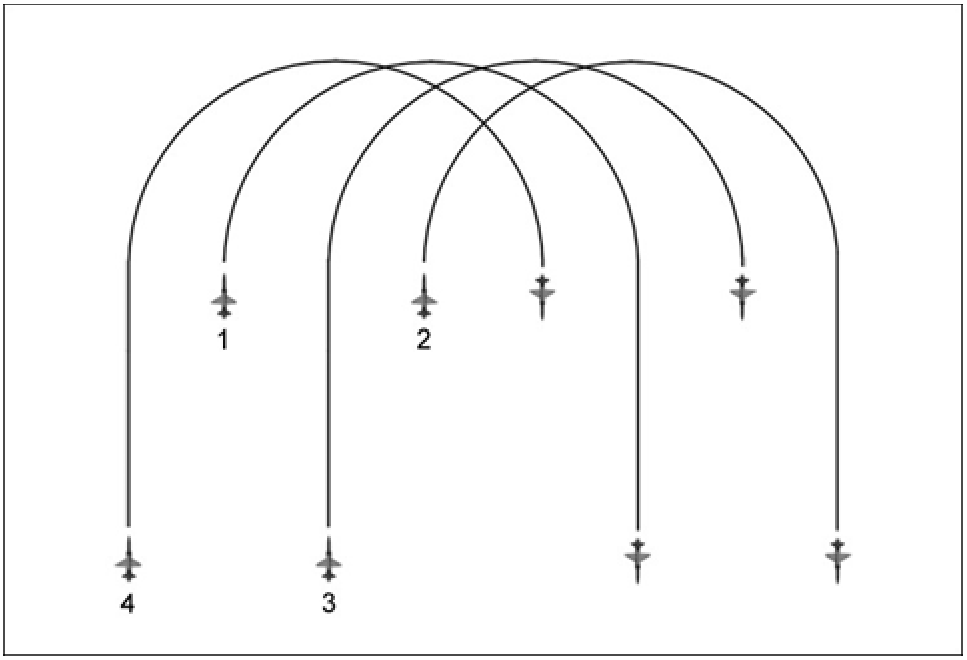


6.41.3.2.2. For turns in box formation, the rear element must delay for several seconds prior to initiating its turn. One technique is for the trailing element to attempt to turn over the same geographical point or the "same point in the sky." For turns in offset box formation, the timing for the trailing element's turn could vary from 3 to 4 seconds (when turning away from the rear outrigger) to 7 to 10 seconds (when turning into the rear outrigger).

6.41.3.2.3. For hook turns in box or offset box formation, lead directs the turn with a radio call ("Card 1 and 2, hook left/right"). The standard hook turn while in box formation is for the second element to delay, so as to remain in trail ("Card 3 and 4, hook left/right"). (**Figure 6.28**). Each element performs a contract hook turn, with all four pilots turning in the same direction. Number 3 delays momentarily prior to turning the second element to complete the turn in trail of the lead element.

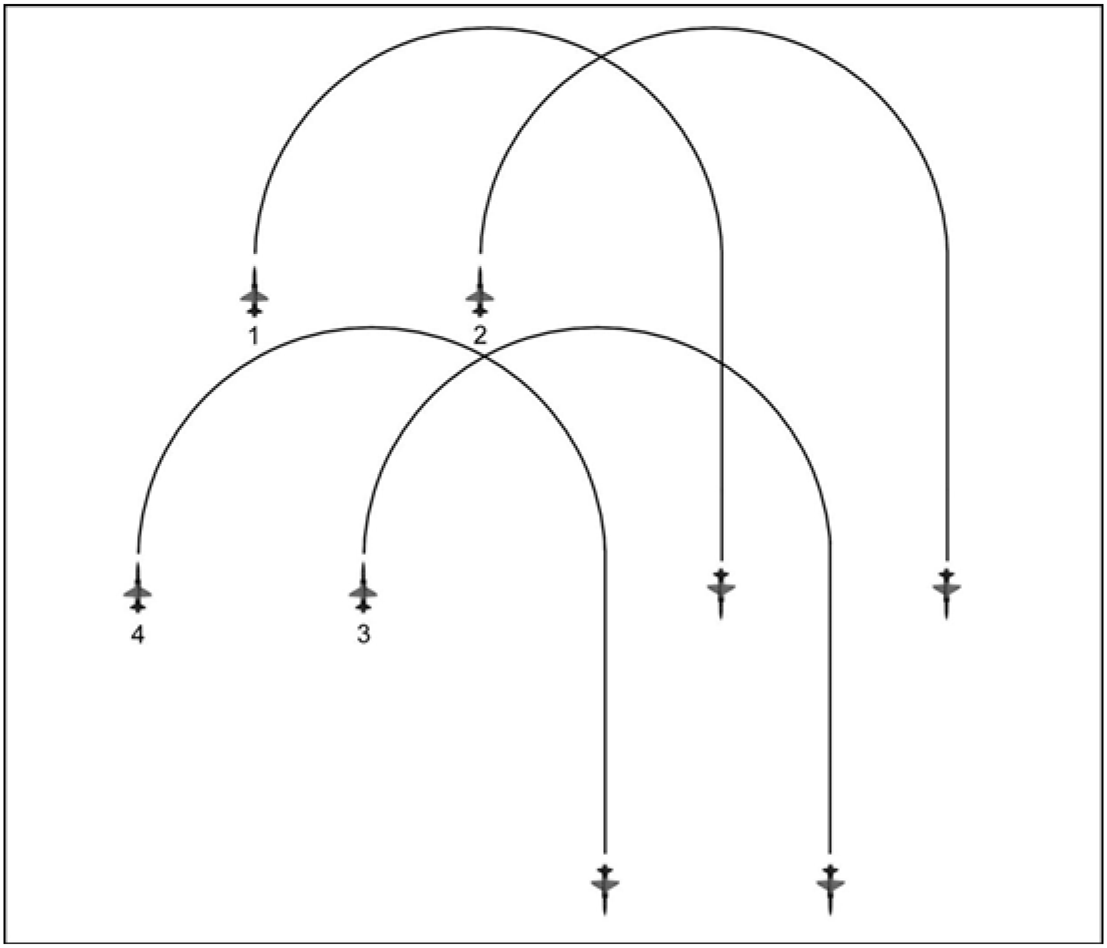
(Generally, the trailing element must start its turn before the lead element passes). If starting level with the lead element, the trailing element must immediately climb or descend to establish vertical deconfliction.

Figure 6.29. Offset Box Formation Hook Turn.



6.41.3.2.4. If lead intends all aircraft to simultaneously hook, thereby placing the trailing element in front, he or she will call for an in-place hook turn ("Colt 21, in-place hook left/right") (**Figure 6.30**). This will put the trailing element out in front of the lead element. A second in-place hook turn in either direction will put the four-ship back in standard box formation. One possible application of an in-place hook turn is while accomplishing a G-awareness exercise.

Figure 6.30. Offset Box Formation In place Hook Turn.



6.42. Three- and Four-Ship Tactical Rejoins. The basic two-ship tactical rejoin concepts also apply to three- and four-ship formations. ***All three- and four-ship tactical rejoins will be called on the radio and acknowledged.***

6.42.1. Straight-Ahead Rejoins. Wingmen will join on lead as described in **paragraph 6.40.2** (straight- ahead tactical rejoin). *Wingmen will not cross lead's 6 o'clock during a straight- ahead tactical rejoin. They will join in sequence and fly no closer than 500 feet to the preceding aircraft until the preceding aircraft are stable in a route or closer formation position.*

6.42.2. Turning Rejoins. ***In a four-ship tactical formation, number 2 rejoins to the inside of lead's turn, number 3 rejoins to the outside of lead's turn, and number 4 rejoins to the outside of number 3. Wingmen will rejoin in sequence and fly no closer than 500 feet to the preceding aircraft until the preceding aircraft are stable in a route or closer formation position.*** Number 4 may use reasonable pursuit on number 3 during the rejoin. Each wingman is responsible for keeping the preceding aircraft in sight and should avoid becoming a conflict or hazard to formation aircraft ahead or behind.

6.43. Three-Ship Options. Maintenance problems will occasionally cause one aircraft to "fall out," leaving a three-ship. Specific details—deputy lead, callsign changes, positions to fly, planned position changes, etc.—should be briefed by lead for each mission.

Section 6D—Fluid Maneuvering (FM)

6.44. Objectives. FM is an advanced building block that introduces the concepts and skills required in future medium-range BFM. FM builds on the short-range maneuvering practiced in ET by requiring the understanding of turn circle geometry and the creative use of pursuit curves and energy management to close from medium to short-range. The objectives of FM are to:

6.44.1. Introduce and practice the administrative setups, terminations, and resets for medium-range BFM.

6.44.2. Introduce and practice the application of air-to-air ROE.

6.44.3. Practice recognizing and solving problems of range, closure, aspect, angle-off, and turning room from a medium-range, simulated "offensive" position behind a cooperative aircraft flying a scripted training profile.

6.44.4. Practice setting and controlling AA and maintaining briefed training parameters for the training aircraft.

6.44.5. Practice maneuvering to, recognizing, and stabilizing in the ET cone from a position well outside that cone, simulating the recognition of a weapons engagement zone.

6.45. Responsibilities:

6.45.1. Collision Avoidance. Flight members must be vigilant with regard to clearing their flightpath and recognizing and avoiding the prebriefed minimum range limitation ("the bubble").

6.45.2. Fuel Awareness. Because FM generally involves higher power settings for longer periods of time, pilots must continually monitor their fuel state to prevent overflying joker or bingo. Leads will call for an ops check before and between engagements.

6.45.3. Setup Standardization. During FM training, the need for setup standardization is critical to the reconstruction, debriefing, and assessment of desired learning objectives. It follows, therefore, that the training aircraft must not deviate from the prebriefed profile ("contract"). Leads are primarily responsible for accurately briefing and aggressively controlling these aspects of FM. The pilot in the maneuvering aircraft must strive to be in the correct starting position and must not call "ready" until the prebriefed starting parameters can be achieved.

6.46. FM Exercise. In addition to fulfilling the common responsibilities in paragraphs 6.48, the two pilots in an FM exercise have distinctly different roles. (See paragraphs 6.50 through 6.62 for details of these roles.)

6.47. Training Aircraft. Although the primary training objectives are for the maneuvering aircraft pilot, there are significant training opportunities for the training aircraft. These include over-the-shoulder SA, POM assessment, lift vector control, floor awareness, G awareness, and energy management. The responsibilities of the pilot in the training aircraft include adjusting bank or backstick pressure to "set" the aspect, monitoring the maneuvering aircraft, and, <u>most</u> importantly, flying the prebriefed parameters ("the contract").

6.48. Maneuvering Aircraft. FM's primary objectives are for the pilot in the maneuvering aircraft. The responsibilities of the pilot in the maneuvering aircraft include being in level, near-pure pursuit to start (gun cross on training aircraft), helping the training aircraft pilot adjust the starting aspect, and remaining vigilant for high over-G potential situations. Between setups, the maneuvering aircraft should maintain or regain the prebriefed position until directed otherwise by lead while climbing at MIL power or 350 KCAS back into the briefed starting block.

6.49. FM Exercise Levels. The building block approach is used in FM training by decreasing the maneuvering limitations of the training aircraft as the wingman's proficiency increases (**Table 6.2**).

Table 6.2. Fluid Maneuvering Exercise Levels (Training Aircraft).

I	A	B	C	D	E
ITEM	**FM Level**	**Maneuver**	**Gs**	**Airspeed**	**Power**
1	1	Level to slightly descending	2 to 4 (note 1)	400 (note 1)	550 EGT
2	2			250 to 400	
3	3	Slight climb/descent (MAX 120 degrees bank)			
4	4 (note 2)	Slight climb/descent (MAX 120 degrees bank)	2 to 5		Military

NOTES:

1. Maintain constant G and airspeed. Increase G as proficiency allows.

2. IP demo or continuation training only. The wingman is allowed use of power up to MAX afterburner.

6.50. Special Instructions (SPINS), TRs, and ROE. These three terms intertwine in their application to training scenarios. Violation of TRs has serious implications for flight safety. Adherence to TRs is essential to becoming a disciplined combat aviator. Outside the UFT and PIT environment, AFI 11-214, *Air Operations Rules and Procedures*, mandates numerous TRs, which have been developed over years of combat aviation training and are designed to provide a safe, effective training environment. Although AFI 11-214 does not apply in UFT or PIT, the concept of TRs remains the same. The term "ROE" has real-world combat applications, but is also commonly used in training. The following ROE apply:

6.50.1. The floor is 1,000 feet above the bottom of assigned airspace.

6.50.2. Power setting—MIL power or less. See **Table 6.2.**

6.50.3. The "bubble"—1,000 feet. (If a transition to ET is briefed, the 1,000-foot FM bubble is no longer applicable after the "in" call.) When the maneuvering aircraft closes to approximately 2,000 feet and approaches a stabilized position, the training aircraft will begin a level to slightly descending turn, maintaining constant G and airspeed.

6.50.4. The training aircraft will not execute turn reversals after the call to begin maneuvering.

6.51. Starting Parameters. A T-38's 400 KCAS, 4 G turn radius at 15,000 feet MSL is approximately 5,200 feet. Therefore, the FM exercise begins at or slightly outside the training aircraft's turn circle as follows:

6.51.1. Altitude block—15,000 to 17,000 feet MSL. (This may be adjusted.)

6.51.2. Airspeed—400 (± 10) KCAS.

6.51.3. Maneuvering aircraft pursuit—pure pursuit, stacked level.

6.51.4. Aspect angle—30 to 45 degrees or as briefed. The maneuvering aircraft is just forward of the training aircraft's wingtip. (This may be adjusted for training objectives.)

6.51.5. Range—6,000 feet.

6.51.6. Stack—Level (±500ft)

6.52. Setup Comm. Each setup should be preceded by an ops check, a descriptive preparatory call ("Lance 01, next set FM level 3 for #2". "2".)

6.53. FM Exercise Setups. There are three ways to set up the FM exercise; from directed positions, from a pitchout, or from tactical formation. Flexibility will afford every opportunity to maximize training despite area and (or) weather constraints.

6.53.1. From Directed Positions. This option is a little more comm.-intensive, but is especially efficient for dealing with weather-restricted airspace. Lead maneuvers or directs the flight as necessary back into the block and back to clear airspace for the next setup. The maneuvering aircraft simply maintains a directed position until directed to a different position by the flight lead.

6.53.2. From a Pitchout. Lead can accelerate in a route position to starting airspeed before the pitchout or direct acceleration afterward. The maneuvering aircraft delays to rollout 7,000 to 9,000 feet (about 5 to 6 seconds) behind lead. The training aircraft turns to acquire a visual and set the desired aspect. When the range decreases to 6,000 feet, the call is made to begin maneuvering.

6.53.3. From a Tactical Formation:

6.53.3.1. After maneuvering into the block, completing setup admin, and acknowledging the descriptive call for the next exercise, the maneuvering aircraft slides out to 7,000 to 9,000 feet LAB. If transitioning from a 350 KCAS climb or tactical, an acceleration maneuver is required and will be directed by lead ("Lance 01, push it up, reference heading 180", "2".) If transitioning from 400 KCAS tactical, no acceleration maneuver is required. The wingman should strive to be ready before the flight lead. Once the flight lead calls "Lance 1 ready", the wingman will respond immediately with his/her status ("Lance 2 ready" or "Lance 2 standby airspeed/stack/spacing/etc."). If the wingman makes a "standby" call, he/she will call ready as soon as they are in starting parameters for the exercise.

6.53.3.2. After the "ready" calls, lead directs a check turn into the training aircraft ("Lance 01, check left." The training aircraft normally turns about 45 degrees away from the maneuvering aircraft, but may adjust as necessary. The maneuvering aircraft continues the turn as needed to place the gun cross on the training aircraft. The training aircraft acquires visual on the wingman, remains on the roll-out heading until the wingman has achieved pure pursuit, and then reverses the turn and adjusts back stick pressure to "set" the desired aspect. The maneuvering aircraft will verify the correct aspect angle and call "ease off" or "tighten up" if required. When range decreases to 6,000 feet, the call is made to begin maneuvering from the maneuvering aircraft ("Lance 01, fight's on.")

6.53.4. Avionics. Lead and wing should select the A/A master mode after lead's descriptive preparatory radio call. ***The A/A master mode will be selected prior to the respective ready call.***

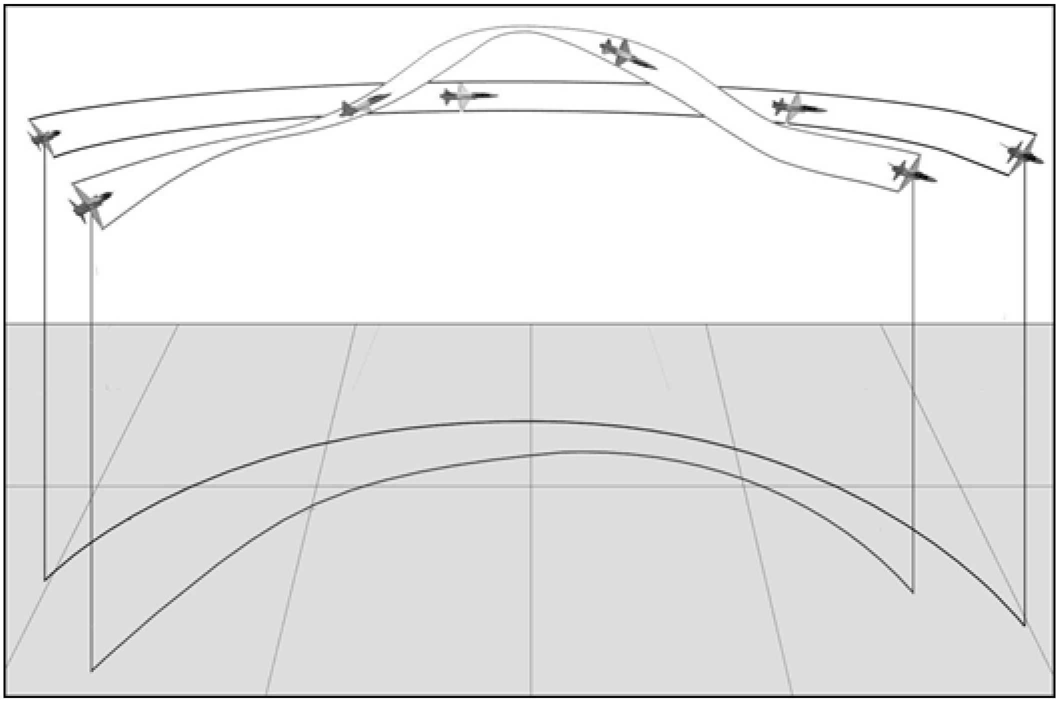
6.54. Initial Moves:

6.54.1. Finding the Turn Circle. If the call to begin maneuvering comes right at 6,000 feet, the opening move is normally a delay to preserve turning room. From 6,000 feet, just a small delay will preserve the optimum turning room for the offensive break turn, which should be executed on—or close to—the training aircraft's turn circle. Use caution during this delay to ensure the airspeed does not increase beyond that desired for the break turn. The aspect of the training aircraft will increase during this delay. The delay may be accomplished in-plane or out of plane. (Many pilots prefer to create some vertical turning room as well by adding a slight climb to their delay.)

6.54.2. Break Turn. A break turn too early—from inside the training aircraft's turn circle—will cause a cut across training aircraft's turn circle, which quickly decreases range, but also creates very high aspect. A break turn too late will waste turning room, cause a turn circle overshoot, and result in excessive lag and range. To execute the first break turn, roll to place the lift vector approximately on or slightly below the training aircraft and smoothly apply backstick pressure in a symmetrical pull to stop the training aircraft's LOS across the canopy. The goals of the first break turn are to realign fuselages as much as possible and decrease range while preserving enough energy and turning room to solve subsequent geometry problems. Heightened G awareness and careful reference to current G on the HUD are required to prevent over-Gs during the first break turn.

6.55. Lag Reposition. The lag reposition (**Figure 6.31**) is used to generate turning room to solve excessive closure and angle-off problems.

Figure 6.31. Lag Reposition.

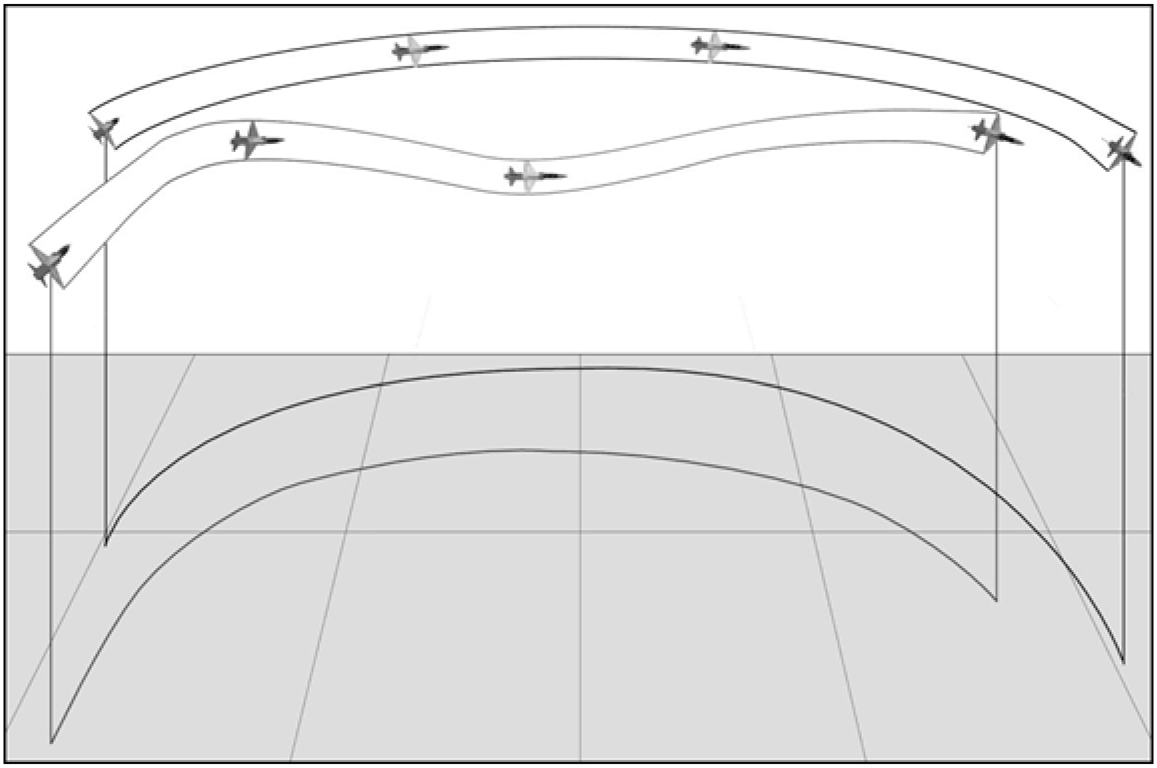


6.55.1. Position your lift vector up and out of the training aircraft's POM. (The out-of-plane angle required will vary. In cases where aspect is decreasing too slowly, a lift vector position of more than 90 degrees to the training aircraft's flightpath may be necessary). Add backstick pressure as required to generate turning room.

6.55.2. Once sufficient turning room has been achieved, crisply roll back to place the lift vector on or below the training aircraft and pull to attempt to align fuselages. Use the radial G and out-of-plane turning room made available by the lag reposition to help establish lead pursuit. Once established in the ET cone, call "in." The entire lag reposition is normally flown at the maximum allowable power setting (MIL for UPT or PIT).

6.56. Lead Reposition. The lead reposition (**Figure 6.32**) is used to generate closure to decrease range while preserving or building energy.

Figure 6.32. Lead Reposition.

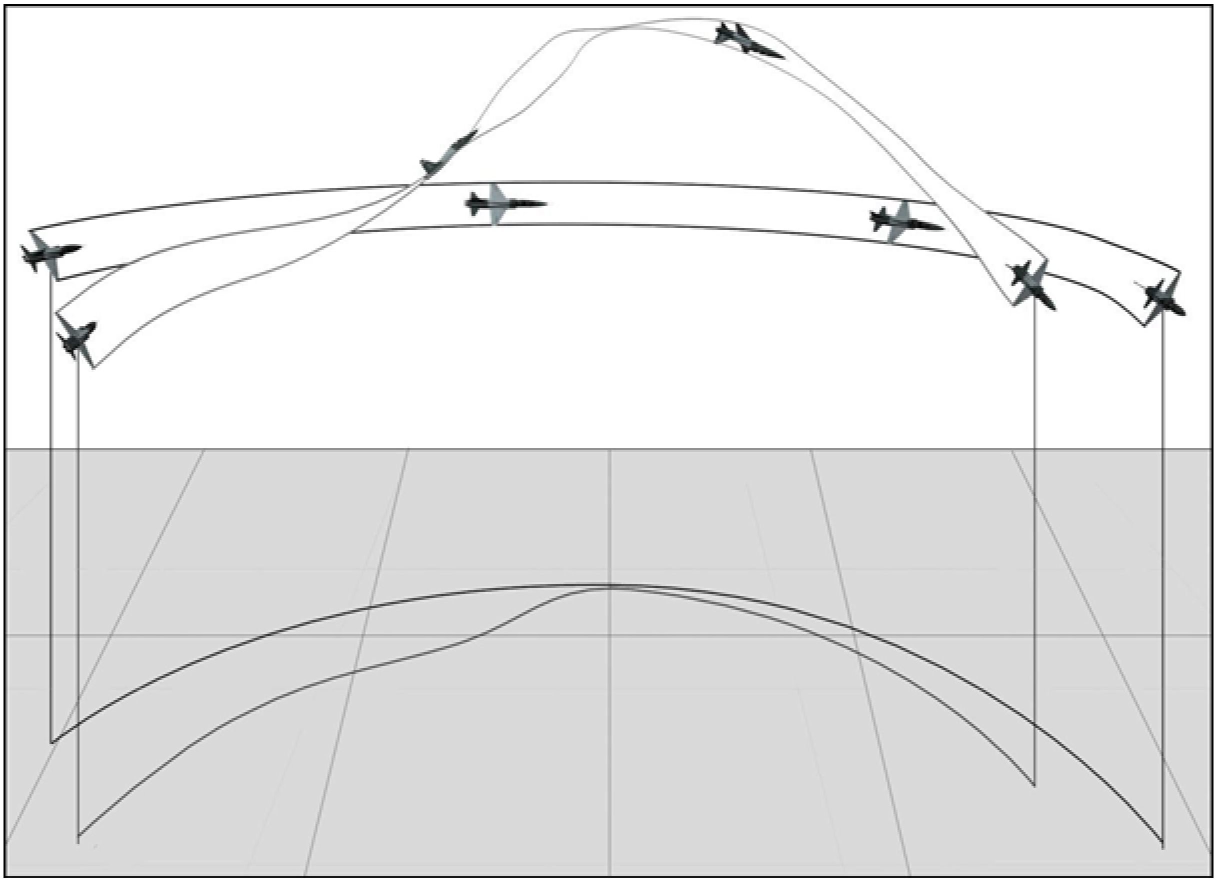


6.56.1. Place the nose and lift vector such that you pull lead pursuit in a POM below the training aircraft. (How much lead and (or) descent will vary with range, closure, the training aircraft's LOS, and your energy state.) This out-of-plane maneuver uses turning room below lead. Analysis of the training aircraft's LOS will tell you whether you need more or less lead pursuit. When desired range or closure is reached, a lag maneuver or reposition may be required to preserve turning room for realigning fuselages. Once established in the ET cone, call "in".

6.56.2. Until the end-game, the lead reposition is normally flown at the maximum allowable power setting (MIL for UFT or PIT). Note that the "picture" during a lead reposition may at times look very similar to that of a turning rejoin.

6.57. Quarter Plane. The quarter plane (**Figure 6.33**) is an exaggerated lag reposition used as a last- ditch maneuver to control closure and prevent a 3/9 line overshoot (often referred to as "preserving the 3/9 line") at close ranges and high LOS rates.

Figure 6.33. Quarter Plane.



6.57.1. Crisply rollout of plane and pull to the training aircraft's high 6 o'clock. The pull out-of-plane is at least—and often more than—90 degrees from the training aircraft's POM, but the amount depends on closure, range, and aspect. This pull to the training aircraft's "high six" reduces closure and aspect to prevent the loss of 3/9 line advantage.

6.57.2. A momentary power reduction may be required, but leaving the power back at high AOA with the nose up can quickly result in an excessive loss of energy.

6.57.3. Following the pull and once assured you will maintain 3/9 line advantage, unload and crisply roll to regain a visual and analyze your new position. Key on the training aircraft's LOS. If the training aircraft is still moving aft, the closure problem is probably not yet solved. If the training aircraft is stopped or moving forward, closure is under control. Once established in the ET cone, call "in".

6.58. Transition to ET. If briefed, FM may culminate with a transition to the maneuvering phase of the ET exercise. A radio call from the maneuvering aircraft (for example, "Lance 2's in.") usually marks the transition, after which both pilots will adhere to ET parameters and restrictions.

6.59. Post-Terminate Flow. The normal post-terminate maneuver is a reset to tactical with a climb back to the starting altitude block. The reset to tactical is dynamic due to the likely differences in airspeed between lead and wing. Minimal time should be spent heads down in the cockpit for both lead and wing while the formation resets to tactical. Lead must maintain a vigilant lookout for wing as wing solves tactical formation problems.

6.59.1. After the terminate or knock-it-off call, wing will check to lag the training aircraft and set military power. Lead will reverse the direction of turn, set military power and achieve and maintain 350 KCAS in the most energy efficient manner (airspace permitting).

6.59.2. The timing of lead's turn reversal will be relative to wing's position at the terminate call and will put wing LAB. Once LAB, wing will set pitch and airspeed as required to remain line abreast and attain 4,000 to 6,000 feet spacing.

6.59.3. The only communication required is during the termination drill. After the termination drill, a reference heading by lead may increase wing's SA but is optional. Wing must continuously assess lead and maneuver to stay in position.

6.59.4. Once the formation is reset to LAB, wing must rely on visual cues from lead's aircraft to maintain tactical position and continue an efficient climb to the starting altitude block. During the climb, it is essential both aircraft maintain 350 KCAS without bleeding off airspeed in the turns. Lead may elect to turn at less AOA than a level tactical turn. Wing must evaluate lead's turn rate and adjust turn timing and turn rate to stay in position. Typically these turns are referred to as "easy" turns.

6.59.5. Avionics. ***Lead and wing will return to the NAV master mode after the terminate drill and no later than completion of the post-terminate ops check.***

6.60. Blind Procedures. If any aircraft goes blind, he/she will immediately call "no joy". If the maneuvering aircraft is blind, he/she will lag the training aircraft's last known position and power modulate as required to maintain current airspeed (300kts minimum) and altitude. If the training aircraft is blind, he/she will remain predictable (which usually means continuing the turn under current parameters).

6.60.1. If the other aircraft is visual, he/she may direct the blind aircraft to continue while talking the blind aircraft onto the visual. "Lance 2, no joy". "Lance 2, continue, visual is your 2 o'clock, slightly low." Once the blind aircraft calls "tally" he/she may continue maneuvering. If the blind aircraft does not regain the visual immediately, either aircraft may call a knock-it-off.

6.60.2. If both aircraft are blind, call a knock-it-off, establish altitude deconfliction, and the training aircraft must be directive with the wingman in order to deconflict and regain mutual support**.**

Section 6E—Handling Abnormal Situations in Formation

6.61. Takeoff Aborts.

6.61.1. Formation Takeoff:

6.61.1.1. If an abort becomes necessary, maintain aircraft control, ensure separation from the other aircraft by maintaining your side of the runway, and make a radio call as soon as practical ("Flank 2 is aborting, barrier, barrier, barrier."). However, do not sacrifice aircraft control to make a radio call.

6.61.1.2. During a formation takeoff, there will normally be no sympathetic aborts within the element after brake release. Sympathetic aborts can create situations where a good aircraft is risking simultaneous barrier engagement, hot brakes, or blown tires.

6.61.1.3. ***During an abort situation, the aircraft continuing the takeoff will maintain its side of the runway, select full afterburner, and execute a normal single-ship takeoff.*** If lead determines both aircraft should abort, he or she will direct the wingman to abort. For example, lead will transmit, "Sting 21 flight, abort, abort, abort." Being in minimum afterburner and still overrunning lead could be the first indication that lead is aborting. If this occurs, accomplish a separate takeoff.

6.61.2. Interval Takeoff. If you abort as lead, make a radio call to your wingman. It is difficult for the wingman to recognize an abort using only visual cues. If, as the wingman, you have not released brakes, reduce your power and hold your position until lead clears the runway. If you have started the takeoff roll but are below 100 knots, consider aborting because you may not have sufficient spacing to takeoff behind lead. If you are above 100 knots, you should continue the takeoff using MAX afterburner.

6.61.3. Element Abort. If an element abort is necessary, each aircraft must maintain its respective side of the runway and make every effort to stop prior to the end of the runway. ***Any aircraft requiring a barrier engagement should transmit its callsign and "barrier, barrier, barrier."*** If neither aircraft can stop prior to the end of the runway, the first aircraft to the barrier will engage the barrier and the second aircraft will take any necessary action to prevent barrier engagement, to include departing the runway surface.

6.62. Airborne Emergencies. As much as possible, maintain formation integrity for all airborne emergencies. If any aircraft malfunction occurs while in close formation, ensure aircraft separation before handling the emergency. The pilot of an aircraft experiencing an abnormal situation will advise lead of the problem, his or her intentions, and assistance required.

6.62.1. Lead. As a minimum, offer the lead to a wingman as soon as you realize he or she has an aircraft malfunction and is in a position to take the lead. If the wingman refuses the lead, try to pass the lead on recovery and on final with clearance to land or as the situation dictates. Except in unusual circumstances, do not land in formation with a disabled aircraft. If the wingman is able to transmit and receive with the radio, give him or her verbal assistance as necessary. Follow the preflight briefing instructions for emergencies so the wingman knows what to expect.

6.62.2. Wingman. When an aircraft malfunction is discovered, call "knock-it-off" and then inform lead of the problem. Normally, if you are able to communicate with outside agencies and navigate, take the lead when offered. As much as possible, avoid flying the wing position with an emergency. If you must fly the wing position with an emergency, fly no closer than route spacing when weather allows.

6.62.3. Radio Failure. An aircraft experiencing radio failure will normally assume or retain the wing position. If experiencing radio failure as lead, put the wingmen in route and give the appropriate AFI 11-205 visual signal. Then pass the lead to either number 2 or number 3 as appropriate. If experiencing radio failure as a wingman while in close or route formation, maneuver within close or route parameters to attract the attention of another flight member, and give the appropriate visual signals. In other positions, do not rejoin closer than 500 feet.

Rock your wings to gain lead's attention, and wait for a rejoin signal from lead. When signaled, rejoin as close as necessary to pass the appropriate visual signals.

6.62.4. Lost Wingman Procedures:

6.62.4.1. Lead. To minimize the possibility of a lost wingman situation, brief pertinent IMC procedures during the preflight briefing. Bring all wingmen into fingertip spacing, and reform any three- or four- ship formation into fingertip prior to entering IMC.

6.62.4.2. Wingman. If lead fails to coordinate for a separate clearance, contact the controlling agency. Keep in mind that lost wingman procedures do not guarantee obstacle clearance when close to the ground. Therefore, each pilot who is executing lost wingman procedures is responsible for terrain and obstacle clearance.

6.62.5. Bird Strike. If a bird strike appears imminent, do not hit the other aircraft in an effort to miss the bird. The primary concern is still aircraft separation. If a bird strike does occur, ensure aircraft separation before handling the emergency. Lead should consider the option of a wing landing if the rear cockpit pilot must land the affected aircraft and forward visibility is severely restricted.

6.62.6. Lost Sight. In some cases, losing sight of the other aircraft does not require a breakout or lost wingman procedure because sufficient spacing already exists. If the other aircraft is not in sight when anticipated, use the following procedures:

6.62.6.1. Notification. Notify the other aircraft of your situation ("Sting 2's blind."). In some cases, heading, altitude, or turn information may also be appropriate with this call. If only lead is blind, the call "Sting 2 posit?" is posed as a question for the wingman, who responds with his or her position ("Sting 2, visual, your right 3 o'clock, high").

6.62.6.2. One Aircraft Is Blind. If the other aircraft has not lost sight, transmit "visual" with a relative position to the blind aircraft. If lead is the blind aircraft, but the wingman has lead in sight, lead has the option to direct a rejoin or continue to search for the wingman based on the response to a "posit" call.

6.62.6.3. Both Aircraft Are Blind. If both aircraft have lost sight, lead will immediately ensure a minimum of 1,000 feet altitude separation. Once separation is assured, TCAS may be used to affect the rejoin. By determining relative position and heading, lead can determine a rejoin geometry that will allow both aircraft to close and regain the visual. Lead will be directive and may use terms as" "reference" for heading, "set" for airspeed, and "maintain" for altitude. Wing will comply with these directives establishing lead's determined geometry to attain visual. Both aircraft will maintain altitude separation until one aircraft regains visual. The aircraft that gains visual may request the other aircraft to rock its wings for positive identification. The aircraft with the visual is responsible for maintaining separation and may request the other aircraft to maneuver to maintain the visual.

6.62.6.4. Three- or Four-Ship Formations. All members of a multi-ship formation should strive to maintain visual on all other members of the formation. However, the wingman's primary responsibility is to maintain visual on his or her element lead. If a member of the flight loses sight of any other aircraft, call blind or visual with the number of aircraft seen ("Snake 4, blind" or "Snake 4, blind, visual two aircraft"). With high situational awareness, call blind on the appropriate aircraft ("Snake 3, blind on 2".) This call may be delayed if there is no doubt as to the identification of the aircraft with which they are visual, and no conflict exists. For instance, in wall or offset box, if a wingman loses sight of the opposite wingman but has maintained visual on his or her element lead and lead, a "blind" call would not be required. If any doubt exists, call "blind".

6.62.7. Midair Collision. ***If a midair collision occurs between formation members, under no circumstances will they act as chase ships for each other.***

6.62.8. Ejection. If one aircraft in a formation must perform a controlled ejection, the chase ship should fly abreast of the disabled aircraft and no closer than 1,000 feet.

6.62.9. Spatial Disorientation:

6.62.9.1. Lead. If you experience spatial disorientation as lead, immediately advise the wing-men, and if possible, transfer aircraft control to the other crewmember. If transfer of aircraft control is not an option, confirm attitude with the other crewmember or wingmen. If symptoms persist, terminate the mission and recover the flight by the simplest and safest means possible.

6.62.9.2. Wingman. Wingmen experiencing spatial disorientation will advise their other crewmember and (or) lead when disorientation makes it difficult to maintain position. The crewmember not in control of the aircraft or lead will advise the wingman of aircraft attitude, altitude, heading, and airspeed. If symptoms persist and conditions permit, lead should establish straight-and-level flight for 30 to 60 seconds and consider passing the lead to the disoriented wingman. If necessary, terminate the mission and recover by the simplest and safest means possible.

6.62.9.3. Three- and Four-Ship. Lead should separate the flight into elements to more effectively handle a wingman with persistent spatial disorientation symptoms. The element with the disoriented pilot should remain straight-and-level while the other element separates from the flight.

Chapter 7

INSTRUMENTS

7.1. Introduction. Instrument flying procedures are described in detail in AFMAN 11-217, Volume 1, *Instrument Flight Procedures*. There will be circumstances when you must rely on your instrument flying ability to operate safely. This section will familiarize you with a few of the instrument procedures specific to the T-38.

7.2. Instrument Cross-Check. The control and performance concept is the foundation of good instrument flying. The T-38 HUD is certified as a primary flight reference (PFR) and may be used as a standalone reference for instrument flight. **Note:** Use the UFCP AUTO/DAY/NIGHT toggle switch and H BRT control to set the desired HUD brightness during changing visual conditions. A solid instrument cross-check will use control instruments (attitude indicator, HUD pitch/bank scales, and engine tachometers) and performance instruments (HUD or MFD altimeter, airspeed indicator, vertical velocity, AOA, and horizontal situation indicator [HSI]) to:

7.2.1. Establish an attitude and power setting on the control instruments. **Note:** Setting precise pitch settings is easiest on the HUD; however, it may increase potential for spatial disorientation or complicate the cross-check during IMC.

7.2.2. Trim until control pressures are neutralized.

7.2.3. Cross-check performance instruments to determine if the established attitude and power settings are providing the desired performance.

7.2.4. Adjust attitude and power setting using control instruments, and re-trim as necessary.

7.3. Prior to Instrument Takeoff (ITO). Update weather conditions and TOLD; review the instrument departure, radar routing, terminal approach NAVAIDs and radar approach capability at the departure airfield, and review an emergency return plan based on single-engine climb capability and obstacle features of the departure airfield. Set up your NAVAIDs accordingly.

7.4. Rear Cockpit Takeoffs with an Instrument Hood. As you start to close the rear canopy, pull the instrument hood forward enough to ensure it will remain clear of the canopy rails and the canopy piercer on top of the ejection seat. When the rear canopy is fully closed, pull the instrument hood back out of the way.

7.5. ITO. The ITO is similar to the transition takeoff except you will transition to instruments as outside visual references deteriorate. Once airborne, hold a wings-level, takeoff attitude by setting 7 degrees nose-high on the bore sight cross (F-16 HUD) or waterline (MIL-STD HUD) and confirm a definite rate of climb. After verifying a positive climb on the altimeter and a positive vertical velocity, retract the landing gear and flaps. As visual references deteriorate, the decision to transition to either the HUD or EADI will be based on proficiency, experience, and comfort level with interpreting the applicable display. During this critical phase of flight, a composite cross-check is essential especially if using the HUD as the primary flight reference. **Note:** Use extreme caution when transitioning to instruments during the takeoff. The pitch changes associated with gear and flap retraction in the T-38 may cause momentary disorientation at very low altitude. A proper instrument cross-check is essential to maintain SA during this phase of flight.

7.6. Instrument Departure. In most cases, you will use the restricted MIL power climb schedule for instrument and navigation departures. You must maintain a constant cross-check in order to divide attention between aircraft control, departure procedures, and checklist duties. This can be accomplished by quickly completing one item at a time and returning to your instrument cross-check in between, with primary emphasis on the EADI or HUD.

7.7. Level Off. The lead point for level off, from either a climb or descent, will vary depending on the vertical velocity you are using. The following techniques will help you develop smooth lead points:

7.7.1. With low or moderate climb or descent rates, begin the level-off at 10 percent of the vertical velocity reading. For example, with a vertical velocity of 2,500 fpm, begin the level-off 250 feet early.

7.7.2. With a vertical velocity greater than 6,000 fpm, reduce the pitch attitude by one-half at 2,000 feet prior to level-off, and then use 10 percent of the vertical velocity.

7.8. Arc and Radial Intercepts:

7.8.1. Turn Radius.

7.8.1.1. Arc and radial intercept techniques are based on making a 90-degree turn, using 30 degrees of bank in no-wind conditions. Because these techniques are also based on established turns, the slower you roll into 30 degrees of bank, the more you will need to “pad” your lead point. Turn radius lead points for the T-38 in miles can be calculated using the following techniques:

7.8.1.1.1. For higher airspeeds (greater than 300 KCAS), Mach number - 2 = approximate turn radius (in miles) using 30 degrees bank.

7.8.1.1.2. For slower speeds, 1 percent of GS = approximate turn radius (in miles), using 30 degrees bank.

7.8.1.2. To adjust for less than 90 degrees of turn, use the following techniques:

7.8.1.2.1. For a turn of 60 degrees, use one-half of the calculated lead point.

7.8.1.2.2. For a turn of 45 degrees, use one-third of the calculated lead point.

7.8.1.2.3. For a turn of 30 degrees, use one-sixth of the calculated lead point.

7.8.2. Arc-to-Radial Intercepts. After calculating your lead point, use the 60-to-1 rule to translate the lead point in miles to the lead point in radials. For example:

7.8.2.1. Using the 1-percent technique, flying at 250 GS corresponds to a 2.5 NM turn radius. By applying the 60 to 1 rule, on the 10 DME arc where there are 6 radials per mile, use a lead point of 15 radials.

7.8.2.2. At .5 Mach, using the Mach-number-minus-2 technique, the turn radius is 3 NM. On the 20 DME arc where there are 3 radials per mile, use a lead point of 9 radials.

7.9. Basic Aircraft Control Maneuvers:

7.9.1. Vertical “S” Maneuvers. Fly Vertical “S” maneuvers as described in AFMAN 11-217, Volume 1, at various airspeeds and configurations. Normally, use a vertical velocity of 1,000 to 2,000 fpm and a 1,000-foot altitude block. The following techniques can be used to anticipate the pitch and vertical velocity changes at different airspeeds:

7.9.1.1. IMN x 1,000 = vertical velocity change for a 1-degree pitch change. For example, at .6 IMN, you will get about 600 fpm per degree of pitch change.

7.9.2. Steep Turns. Practicing steep turns builds confidence and instrument skills that sometimes become necessary when 30 degrees of bank is not sufficient for safety or other reasons. Practice steep turns at various airspeeds using 45 to 60 degrees of bank. AFMAN 11-217, Volume 1, describes factors associated with flying steep turns. Either holding the HUD FPM or CDM on the horizon line or making desired pitch changes on the EADI can be used to maintain altitude. The HUD heading scale or EHSI can be used for rollouts. In the T-38C, the EHSI makes lead points for rollout negligible, usually less than 5 degrees.

7.9.3. Instrument Aileron Roll. The instrument aileron roll is one of the confidence maneuvers discussed in AFMAN 11-217, Volume 1. As the name implies, this maneuver builds confidence and teaches aircraft control throughout wider ranges of pitch, bank, and airspeed. It also helps develop skills required to recover from unusual attitudes, using the EADI during extreme pitch and bank attitudes. Perform instrument aileron roll as described in AFMAN 11-217, Volume 1, using a minimum of 300 KCAS and 85 percent rpm.

7.9.4. Unusual Attitudes. Refer to AFMAN 11-217, Volume 1, for procedures on recovering from instrument unusual attitudes.

7.10. Direct to Fix (Fix-to-Fix with EGI). Proceeding direct to a radial/DME fix is not a basic requirement to operate in the National Airspace System (NAS) nor does it comply with Federal Aviation Administration (FAA) accepted practices and procedures. Therefore, T-38 pilots will normally use the aircraft's RNAV capability (EGI) when proceeding direct to a fix.

7.10.1. For pilot to file or accept a clearance to navigate direct to a radial/DME fix, either the aircraft must be RNAV capable; the flight must be conducted where radar monitoring by ATC is available; the locally defined arrival/departure procedures must have been authorized by the FAA; or an operational necessity must dictate the requirement.

7.10.2. A common error is mistakenly entering the wrong ICAO identifier. Verify that the bearing and range to the steerpoint makes sense relative to your current position. To proceed direct to a fix using the EGI, type the name of the fix into the UFCP and verify that the bearing and range to the steerpoint make sense. Next, either select EGI as the PNS and center the ground track indicator (PFR, HSD or SIT display) on the EGI pointer. An additional option is to align the FPM in the HUD with the Target Designator (TD) box. Approaching the fix, EGI can be used as the secondary navigation source using the ground track (GT) pointer centered on the EGI pointer to proceed direct. This will allow sufficient time to dial in appropriate follow-on procedures prior to arriving at the fix.

7.11. Fix-to-Fix (without EGI). In accordance with USAF and FAA guidance, EGI is the primary means to navigate directly to a radial/DME fix. However, proceeding directly to a VOR/DME or TACAN fix without the use of EGI can be accomplished to understand the basics of maintaining SA off of a ground NAVAID or common reference point (e.g., determining your position relative to another aircraft off of a bullseye point) and is a valued core competency skill for AF pilots. Normally, this training will only be accomplished in the simulator.

7.12. Arrival Checks. AFMAN 11-217, Volume 1, describes how to prepare for an instrument arrival or approach. One technique for accomplishing arrival checks is the "WHOLDS" check. This check is meant to be a memory aid to ensure required items are accomplished enroute to an initial approach fix (IAF), a holding fix, or prior to beginning an enroute descent. It may also be used between approaches. If an item such as a descent check or obtaining the weather has been accomplished, it does not need to be re-accomplished between approaches. (**Note:** Items in bold and italics are mandatory checks required by AFMAN 11-217, Volume 1.)

7.12.1. WHOLDS—A Memory Aid.

7.12.1.1. **W** eather. ***Recheck weather (if appropriate).*** Determine the landing runway and altimeter setting, and ensure the weather and airfield are suitable for the approach.

7.12.1.2. **H** olding or Heading and Attitude Systems. Obtain clearance to hold, review the holding pattern, and determine the appropriate point to slow to holding airspeed. Review holding entry techniques to determine the most appropriate entry. ***Check heading and attitude systems.***

7.12.1.3. **O** ***btain clearance for the approach*** and coordinate for climb out instructions if applicable.

7.12.1.4. **L** etdown Plate Review or **Lost** Comm. ***Review the IAP.*** Refer to AFMAN 11-217, Volume 1, for approach review techniques. Set up NAVAIDs as appropriate. ***Coordinate lost communication procedures (if required)*** and consider a plan for a backup approach.

7.12.1.5. **D** escent Check. Items on the descent check, such as altimeter settings and airspeeds, may need to be updated in the course of the approach. ***Check the heading and attitude systems.***

7.12.1.6. **S** peeds. Calculate final approach speeds and review configuration.

7.13. Holding:

7.13.1. AFMAN 11-217, Volume 1, provides guidance for holding. Most holding fixes are defined by DME limits; however, there are still many holding patterns that require timing. ATC expects you to slow to holding speed no earlier than 3 minutes prior to the holding fix.

7.13.2. As a technique, begin reducing speed 5 to 10 NM prior to the holding fix (1 to 2 minutes) to ensure entering holding at ***holding airspeeds (250 to 265 KCAS)***. Approximately 88 to 90 percent rpm will hold 250 to 265 KCAS in level flight. When correcting for position and (or) winds, adjust the displacement on the outbound leg to intercept the holding course inbound.

7.13.3. A technique for a no-wind starting point follows: 360 divided by DME equals the number of radials displacement desired at the outbound DME limit. For example, a 30 DME outer limit for holding requires about 12 radials of displacement (360 ÷ 30 = 12).

7.14. Enroute Descents. Enroute descents usually provide the quickest and most efficient way to get from the middle or high altitude structure to a landing. The goal of an enroute descent is to arrive at a point from which vectors to an instrument final can be followed. Continually update the progress of your enroute descent. If in doubt, the conservative choice is to get down a little early. The following techniques will help you determine an appropriate pitch gradient:

7.14.1. Mathematical Gradient. Divide your altitude to lose (in thousands of feet) by the distance to travel (in NM) and then translate the result into degrees of pitch change. For example, you are at a cruising altitude of FL 270, 60 NM from where you would like to be when you reach the final approach fix (FAF) altitude of 2,000 feet MSL. So, with 25,000 feet to lose in 60 NM, you will need a descent gradient of 417 feet per NM. Because each degree of pitch change results in 100 feet per NM, a nose-low attitude of 4 to 5 degrees will work.

7.14.2. Visualizing the Gradient. Divide your altitude (in thousands of feet) by the distance to travel (in NM), and then superimpose that ratio using the first 10 degrees of dive gradients on the EADI. Designate the 10-degree nose-low line on the EADI as the distance to travel. Then visually determine where the altitude-to-lose (in thousands of feet) falls between the level flight line and the 10-degree dive line. For example, using the same scenario as in paragraph 7.14.1, you need to lose 25,000 feet in 60 NM. Designate the 10-degree dive line to be the 60 (NM) and superimpose the 25 (thousands of feet) on the EADI as a visual ratio of altitude over distance. The 5-degree dive line would represent 30 (thousands of feet), so 25 (thousands of feet) would fall about 4 degrees nose-low.

7.14.3. Pitch/Power Techniques. During the initial portion of a high altitude descent— or if the potential for icing exists—consider power settings of at least 80 percent rpm. Also consider engine operating restrictions when changing power at high altitudes. Headwinds and tailwinds can drastically affect the descent distances resulting from any pitch and power setting combination. **Table 7.1** lists pitch and power setting combinations for various 300 KCAS descent gradients.

Table 7.1. Techniques for Various 300 KCAS Enroute Descent Gradients.

I	**A**		**B**	**C**		**D**
		T E				
M	**Descent**		**Pitch Change**	**Power Setting**		**Configuration**
1	200 to 250		2 to 2.5 degrees	20 to25 percent		clean
2	300 feet/nm		3 degrees	30 percent nozzles		
3	500 feet/nm		5 degrees	80 percent rpm		
4	700 feet/nm		7 degrees	idle		
5	1,000 feet/nm		10 degrees	80 percent rpm		speed brake
6	1,300 feet/nm		13 degrees	idle		

7.15. VORTAC Penetration. The purpose of a VORTAC penetration is to descend from an enroute altitude to a position from which an approach and landing can be made using the VORTAC as the primary NAVAID. If the VORTAC and EGI steerpoint are identical or close, use caution not to confuse the bearing pointers. Select the correct PNS before passing the IAF. Penetrations are normally flown at 300 KCAS. However, you may fly the penetration at a slower speed—or slow down early—if factors like a relatively short penetration or a low-DME arc make it smarter to do so. Remember, descent gradient is based strictly on pitch attitude (independent of airspeed). Therefore, an idle descent at 7 degrees nose-low and 300 knots will get you lower in less forward distance than an idle descent at 6 degrees nose-low and 240 knots. If holding is not accomplished, slow to 300 KCAS, and set the inbound course prior to the IAF. Consider requesting maneuvering airspace if your inbound heading does not conveniently align you with the initial inbound course. Remember to set the local altimeter setting IAW Flight Information Handbook procedures.

7.16. Precision Approaches:

7.16.1. Instrument Landing System (ILS). The ILS is a precision approach that provides the pilot with final approach course and glidepath information, as follows:

7.16.1.1. Intercepting Final:

7.16.1.1.1. If you are still up near 300 KCAS during the last segment of a penetration (or as you turn onto the base leg), start slowing down. No later than dogleg to final or approximately 10 to 15 NM from touchdown, you should be slowed to 240 to 260 KCAS. **Note:** From 85 to 87 percent rpm will hold these airspeeds.

7.16.1.1.2. If a VORTAC is located on or near the field, selecting TACAN or VOR as the PNS can provide useful information for position orientation and can provide a lead radial for starting the turn to intercept the final course. If the VORTAC is not located on the field, consider setting the EGI steerpoint to the field or the FAF in order to maintain orientation relative to the field or the FAF.

7.16.1.1.3. No later than after commencing the turn to final, select ILS as the PNS and set the published front course either via UFCP or MFD rocker switch. If the course was previously set and EGI was the PNS, double-check that the EGI did not change the course while updating the navigation solution. Once ILS is selected, all VOR steering disappears. Use all available references and SA for the turn to final; don't expect the bank steering bar to guide you perfectly onto final. If established on a dogleg to final within 30 degrees of the final course, starting the turn to final as the CDI begins to move should allow a comfortable intercept without overshooting final.

7.16.1.2. Prior to the FAF. Configure the aircraft approximately 2 to 5 NM prior to the FAF. Trim and adjust the pitch attitude appropriately on the EADI as the aircraft decelerates. Power settings between 93 and 95 percent rpm will hold final approach airspeed in level flight with gear and full flaps. Use 90 to 91 percent rpm for configurations with 60 percent flaps.

7.16.1.3. Course and Glidepath Control:

7.16.1.3.1. On final, make heading changes of 5 degrees or less for precise course control. Bank angles of 5 degrees or less are sufficient for small, controlled heading changes. To prevent overcorrecting while on the final approach course, make small but positive corrections to centerline deviations. If configured on speed at glideslope intercept, a pitch change corresponding with the glideslope (normally 2.5 to 3.0 degrees) should provide a good initial rate of descent.

7.16.1.3.2. At final approach speeds, you are traveling at approximately 2.5 to 3 NM per minute so a 3-degree pitch change will produce a vertical velocity of about 750 to 900 fpm. Adjust descent rate using pitch changes of 2 degrees or less to start. Then use changes of about 1 degree for precise glidepath control. Course and glideslope sensitivity increases as you approach decision altitude (DA); therefore, smaller corrections are required to regain or maintain "on course, on glidepath."

7.16.1.3.3. Cross-check raw data (glideslope indicator, CDI) to ensure proper performance of the flight director steering. Precise pitch inputs can be made if using the HUD. However, because of the precision available, you must avoid the tendency to chase the flight director. Constantly monitor your altitude in relation to appropriate weather minimums and (or) DA. Monitor your altitude in relation to localizer minimums in case glideslope information becomes unreliable.

7.16.2. Precision Approach Radar (PAR). The PAR is a precision approach for which a final approach controller provides verbal course and glidepath information.

7.16.2.1. Intercepting Final. The precision final approach starts when the aircraft is within range of the precision radar, and contact is established with the final controller. Normally, this occurs approximately 8 miles from touchdown. Prepare and configure the aircraft the same as for an ILS.

7.16.2.2. Course and Glidepath Control. The same basic techniques for flying an ILS (**paragraph 7.16.1**) can be used to fly a PAR. Follow controller instructions for heading control. Bank angles of 5 degrees or less are sufficient for small, controlled heading changes. If called "below" or "above" glidepath, use pitch corrections of l degree on the EADI with corresponding 1 percent rpm changes. If called "well below" or "well above" glidepath, use pitch corrections up to 2 degrees with corresponding 2 to 3 percent rpm changes. As with the ILS, course and glideslope sensitivity increases as you approach DA.

7.16.3. Transition to Landing. When approaching the DA, start glancing outside to pick up the runway or approach lighting. You will need to look through the HUD symbology to see the runway environment which may necessitate adjusting the HUD brightness down. Do not fixate on the HUD while attempting to acquire sufficient visual cues to continue the approach. Transition to a composite cross-check as you gain adequate visual references, but be ready to transition back to instruments if weather conditions deteriorate. After the runway is sighted, cross-check visual cues, glidepath lighting, and instruments to ensure that a safe landing is possible. If you follow the glidepath of a precision approach down through minimums to a landing, your touchdown will be approximately 2,000 feet down the runway. Do not transition your glidepath to the threshold ("Duck Under") in accordance with AFMAN 11-217, Volume 1, paragraph 13.2.4.2.2.

7.16.4. Precision Approach Backup. Whenever you are flying a precision approach, be ready to transition to a backup approach. This could be a transition from a PAR to an ILS (or vice versa), or to a non-precision approach. To make this transition easier, have the approach page and or approach minimums readily available.

7.17. Non-precision Approaches:

7.17.1. Intercepting Final. If intercepting a localizer final, use the same techniques as described for precision approaches (**paragraph 7.16.1.1**). If intercepting a VORTAC final from an arc 12 to 15 NM from the field, normally a 10-degree lead point provides a comfortable intercept to final. This is indicated by the CDI "coming off the wall." Once established on a dogleg to a VORTAC final, approximately 3 to 4 degrees of CDI deflection should provide a good point to turn to intercept final.

7.17.2. Prior to the FAF. Prepare and configure the aircraft the same as for a precision approach (**paragraph 7.16)**.

7.17.3. Non-Precision Final Descent:

7.17.3.1. The goal of a non-precision final is to descend to an altitude—below the weather—from which you can make a safe transition to landing. Therefore, it is imperative that you plan and fly the descent so as to reach the minimum descent altitude (MDA) prior to the visual descent point (VDP).

7.17.3.2. At the FAF, or when directed by the controller to "descend to your minimum descent altitude," lower the nose about 4 to 5 degrees on the EADI. Reduce power by approximately 10 percent rpm to maintain final approach airspeed in the descent. Normally, a descent rate of 1,200 to 1,500 fpm will ensure you arrive at the MDA prior to the VDP. Use caution for intermediate stepdown restrictions prior to the MDA. As a technique, reduce your descent rate 200 to 300 fpm prior to the MDA. Level off above the MDA by an amount appropriate to your proficiency level and readjust power (93 to 95 percent rpm will hold final approach airspeed).

7.17.4. Transition to Landing. If the runway environment is in sight at the VDP and you are in a safe position to land, a 3-degree nose-down pitch change along with a slight power reduction should set up a transition to landing for the normal landing zone. If you begin the transition late or if the runway is sighted after the VDP, you can either accept a slightly longer landing (if runway length and condition allows) or, if weather and conditions permit, use a momentarily steeper glidepath to re-intercept a 3-degree glidepath. ***WARNING:*** Use extreme caution to avoid excessive sink rates during transition to landing. If not in a position to execute a safe landing, execute a low approach, missed approach, or climb out.

7.18. Area Navigation (RNAV).

7.18.1. Introduction –GPS provides many benefits over conventional NAVAIDs including increased flexibility and lower operational and maintenance costs. Most importantly, GPS increases safety through improved accuracy and reliability. To maximize these benefits, the FAA plans to continue reduction of expensive ground-based NAVAIDs. Consequently, pilots operating in the National Airspace System (NAS) will be expected to use RNAV, for both enroute and terminal area operations, as their primary navigation source. This chapter provides a framework of procedures and techniques to conduct RNAV operations in the T-38C.

7.18.2. Authorization– ***The T-38C EGI is authorized for IFR enroute and terminal RNAV operations in the national airspace system. RNAV IAPs may be flown to pilot weather category (PWC) or published approach minimums (LNAV, LNAV/VNAV, circling), whichever is higher.***

7.18.3. Database:

7.18.3.1. GPS and other RNAV procedures rely on data extracted from the aircraft navigation database. The potential for serious navigation errors is created by inherent properties of database creation and its use by pilots and aircraft systems. In order to mitigate these potential errors, pilots must be familiar with the database properties of the T-38C and required procedures.

7.18.3.2. The T-38C utilizes the DAFIF navigation database provided by the National Geospatial-Intelligence Agency (NGA). The database contains a filtered list of airports, navigation aids, waypoints, and instrument procedures. This navigation data is published on a 28-day cycle.

7.18.3.3. ***Use of the T-38C Navigation Data Verification Tool (NVT) IAW the current T-38C NavData Processing and Verification Guide to validate the DTC every DAFIF cycle is mandatory prior to conducting RNAV procedures. Pilots will ensure they have a current database loaded into the aircraft*** by checking the DTS tab on the MDP and confirming the ICAO dates are valid.

7.18.3.4. ***Only those approaches included in the database are authorized. Terminal area and instrument approach procedures must be retrieved in their entirety from the database. Pilots may not alter terminal procedures retrieved from the database or enter them manually.*** This requirement does not prevent creation and storage of additional data, however, it cannot be part of a terminal procedure to include IAF or feeder fixes. This requirement also does not preclude pilots from complying with ATC instructions by proceeding direct to a point on a procedure, or by receiving ATC vectors onto course.

7.18.3.5. Not all STARs, SIDs and IAPs are available in the T-38C DAFIF database. Just because there is an RNAV procedure in FLIP, does not mean there will be a corresponding procedure in the database. Many VNAV approaches will be depicted in FLIP, however, will not be available in the aircraft due to insufficient information in the DAFIF database to display a vertical glidepath. Additionally, there are certain leg types such as arcing, that the MDP cannot process, and thus, will not display. Finally, the database is filtered, limiting available airfield procedures unless they meet the following criteria: RWY >/= 6,000ft, Cat D or E St-in w/ LNAV or LNAV/ VNAV minimums, or GPS in title. It is not always possible to determine why a procedure is not available in the aircraft database but is depicted in FLIP.

7.18.3.6. Database errors have occurred at all stages of database development and use, for this reason ***a paper copy of the applicable procedure must always be available and crosschecked in the terminal environment.***

7.18.3.7. ***Pilots must verify all retrieved database information against the FLIP paper copy. Prior to commencing the procedure, pilots must confirm waypoint name and waypoint type, sequence, course distance and altitudes match charted information*** . Due to database related errors, or differences between the magnetic variation database compared to the date of the magnetic variation survey on charted procedures, the database information may not match the flip. Final course and distance tolerances may differ by up to 5 degrees and 0.1 NM respectively and still be flown, otherwise the procedure is not authorized. When verifying the database information of a STAR with the FLIP, the maximum allowable tolerance between courses is 5 degrees. These same restrictions apply when comparing the FLIP products to the displayed approach as it is being flown. A good technique is to accomplish this data comparison during pre-mission planning on a desktop trainer that has a current ICAO database.

7.18.3.8. In addition, there are other allowable differences between the DAFIF database and FLIP data that do not prevent the procedure from being flown;

7.18.3.8.1. Differences between altitudes in the database and the charted procedure do not restrict use of a terminal procedure. Pilots will use the charted procedure for all altitude references in this case, and report the difference as a database error.

7.18.3.8.2. DAFIF will sometimes display what appears to be a repetitive waypoint such as an IAF for a holding-in-lieu of procedure turn (H).

7.18.3.8.3. DAFIF listing (R) or (L), for right or left, following a waypoint. This depicts the anticipated turn direction. This turn direction may differ from the direction the flight director (FD) indicates, which usually selects the shortest turn.

7.18.3.8.4. IAP procedures from the DAFIF database do not always include step down fixes between the Final Approach Waypoint (FAWP) and MAWP that are depicted on an approach plate. ***Pilots will comply with step down fixes as depicted on the approach plate.***

7.18.3.8.5. Course-to-altitude (CA) legs may be present in the missed approach of retrieved procedures that are not included on the charted procedure. These legs are included from DAFIF, and display an altitude 400 feet above the ground or MDA, whichever is higher.

7.18.3.8.6. Many STARs and SIDs will not show specific course, altitude, and distance information in the DAFIF TERM PROC when retrieved for comparison to the paper FLIP. This does not prevent the procedure form being flown; it puts more emphasis on the comparison of displayed leg data while flying. If deviations are determined beyond stated tolerances at any time during the procedure, discontinue the procedure.

7.18.4. Limitations:

7.18.4.1. ***The T-38C is not currently authorized to conduct Required Navigation Performance (RNP) Procedures.*** RNP procedure certification requires different equipment with much more accuracy compared to the T-38C EGI. Do not mistake an RNP procedure, any procedure with “RNP” in the title, with the RNP that appears on the MFD indicating the CDI sensitivity. The RNP in the T-38C refers to the phase of flight and associated CDI scaling.

7.18.4.2. ***RNAV substitution for an out of service NAVAID on a conventional procedure is limited to DME only.*** Bearing and radial guidance are not accurate due to the T-38 EGI not compensating for the applied magnetic variation of the substituted NAVAID. Attempting to navigate Victor and Jet routes using EGI will result in significant deviations in desired ground track as well. You are permitted to proceed direct to a NAVAID or even track a bearing/radial off of an ICAO waypoint. You will not use specific bearing/radial substituted NAVAID guidance for navigation. You may also define Victor and Jet routes in EGI using a flight plan if waypoints/NAVAIDs are retrieved from the database, and all points entered are associated with a change of course.

7.18.5. General:

7.18.5.1. RNAV procedures are developed to ensure the least capable system meets a basic minimal compliance level. The T-38C may exceed basic compliance levels in many areas and may even automatically comply with the required procedures.

7.18.5.2. ***Receiver Autonomous Integrity Monitoring (RAIM) is required for use of GPS in IFR navigation.*** RAIM is continuously monitored in the T-38C and confirmation of required accuracy is the absence of a PFL-- no news is good news. If you lost RAIM, an avionics malfunction would create a PFL. This would probably be due to a loss of satellite coverage. Due to the fact the T-38C has barometric aiding, where altitude information is provided directly from the ADC, RAIM validates GPS integrity utilizing just 4 satellites.

7.18.5.3. ***Pilots must check Predictive RAIM (PRAIM) prior to departure when possible.*** This may be accomplished during pre-mission planning via **www.sapt.faa.gov**, or by loading the planned IAP during ground operations. In the T-38C, PRAIM is automatically checked when an IAP is first loaded, and again when the aircraft is steering to and within 4 NM of the FAWP. When an IAP is loaded on the ground, the MDP uses 1+15 as the planned ETE to determine the projected satellite coverage. If an IAP is loaded while airborne or is steering to and within 4 nm of the FAWP, the actual aircraft groundspeed and track are used to determine ETE, corresponding predictive coverage, and associated required accuracy. Again, as with RAIM, the absence of a PFL means the system meets required PRAIM requirements.

7.18.5.4. The FCP has the ability to monitor the HUD and MFD allowing a continuous CDI display in the HUD and an HSD or SIT display on the MFD. Additionally, the HUD will indicate when in the Terminal (TRM) and Approach (APR) phases of flight. FCP and RCP RNAV procedures are the same; there are just different techniques used to accomplish them due to the cockpit specific displays.

7.18.5.5. ***PFR or HUD are the primary displays for RNAV Terminal Procedures in order to comply with the accuracy mandated by CDI scaling.*** When PFR is used, momentary selection of HSD or SIT may be used to augment situational awareness. Flight director course selection is encouraged to assist lead-turn anticipation and procedure compliance. Pilots should calculate lead turns to maximize situational awareness of when the FD will command a turn to intercept the next segment.

7.18.5.6. ***Pilot will verify the displayed RNP/CDI scaling is correct*** . It is imperative that pilots know the aircraft's phase of flight and corresponding CDI scaling parameters. RNP is automatically adjusted based upon how the selected terminal procedure was built, and the current phase of flight, which is based on the distance from the airfield where the TERM PROC is selected.

Table 7.2. Auto RNP by Phase of Flight.

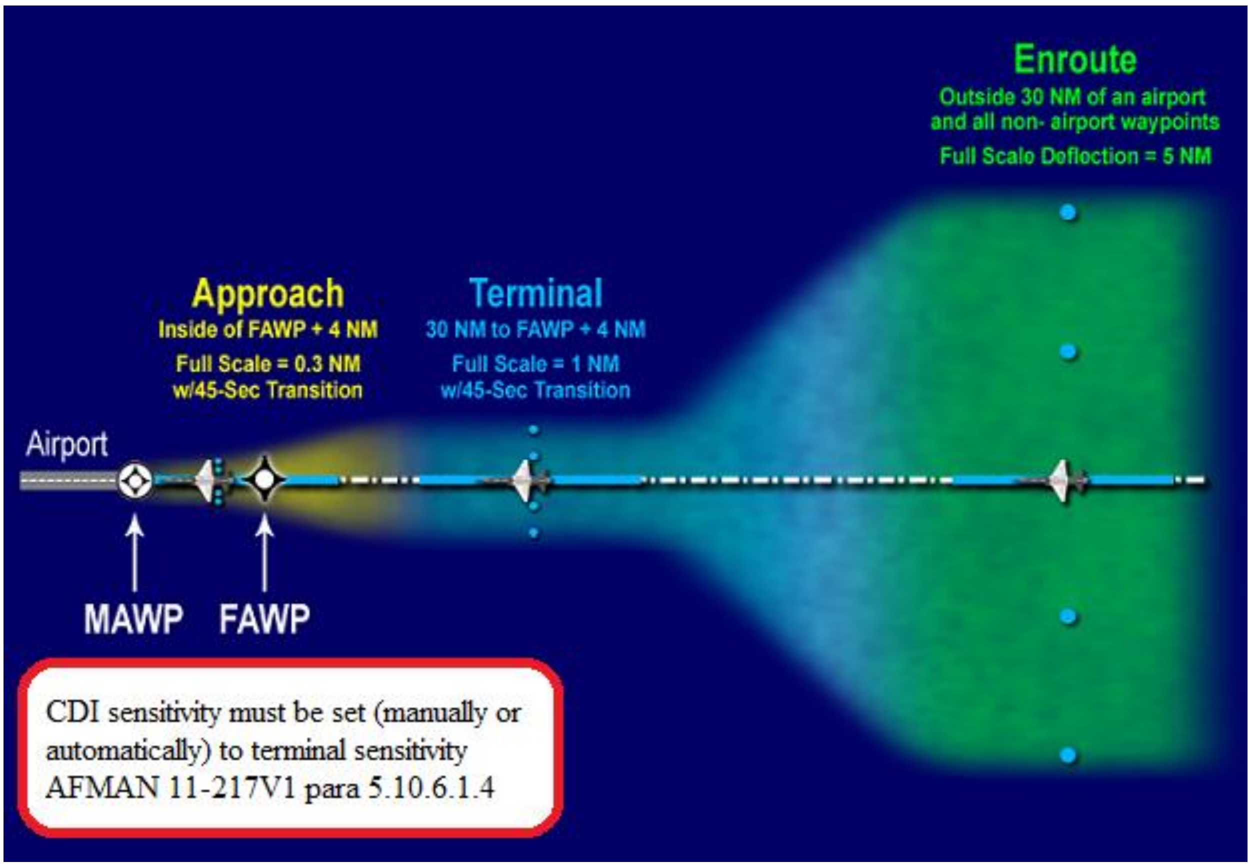
Phase of Flight	RNP/CDI Scale (Full scale deflection)
Enroute (> 30 NM)	5 NM
Terminal (TRM) (NLT 30 NM)	1 NM
Approach (APR) (NLT FAWP)	0.3 NM

7.18.5.7. When flying a Q or T route, the pilot will need to manually adjust the RNP to 2 NM. Additionally, some procedures are not built to scale down the RNP to 1 NM when outside of 30 NM from the airfield. In these cases, the pilot will need to manually adjust the RNP to 1 NM.

Table 7.3. Manual RNP by Phase of Flight.

Phase of Flight	RNP/CDI Scale (Full scale deflection)
Flying Q or T route	2 NM
Terminal Procedure (> 30 NM)	1 NM

Figure 7.1. Automatic RNP Scaling.



7.18.5.8. If manual CDI scaling is required, return the system to automatic scaling when the need for manual override has passed. This includes transitioning from a Q or T route to a terminal procedure, or when arriving inside of 30 NM from the airfield on a terminal procedure which required manual scaling. To return the system to automatic scaling, input 0.0 into the RNP window on the UFCP EGI page.

7.18.5.9. RNP equates to Phase of Flight; however, the MFD may indicate a lesser value based on procedure design. Actual Navigation Performance (ANP) is the estimated accuracy of the EGI/INS in tenths of a mile.

7.18.5.10. Suspend (SUSP) is an option at the bottom of the MFD when a TERM PROC is activated with EGI as PNS. Selecting SUSP allows you to select a course and prevents the flight plan from advancing to the next waypoint. It is critical to remember to deselect SUSP once the need to SUSP has passed.

7.18.5.10.1. Selecting SUSP does not prevent the course from automatically changing when the EGI steer point is changed by other than the inc-dec. It also does not prevent the phase of flight from automatically changing at the prescribed distance.

7.18.5.11. The MDP defaults to “Direct-To” to automatically provide a turn radius corrected course to a selected waypoint. “Direct-To” can be manually de-selected on Menu2 of the MFD. If you do not want to move the inc-dec in order to advance a waypoint on the UFCP, you could consider deselecting “Direct-To” to prevent a change in a suspended course. This might occur while being radar vectored to final but not yet within a 90 degrees intercept to the final approach course. Some may prefer this technique as opposed to continuously changing the inc-dec between EGI steer point and UHF radio selection.

7.18.6. Preflight:

7.18.6.1. In addition to departure, drop in, destination, and alternate airfield NOTAMs, pilots are required to check DAFIF and GPS NOTAMs. GPS NOTAMs may be checked through Flight Service Stations (FSS), or on the Defense Internet NOTAMS System (DINS) website by typing KGPS in the ICAO identifier window, or by selecting the GPS/WAAS tab. Satellites included in the NOTAMs as unserviceable are automatically excluded in the navigation solution due to Fault Detection and Exclusion (FDE).

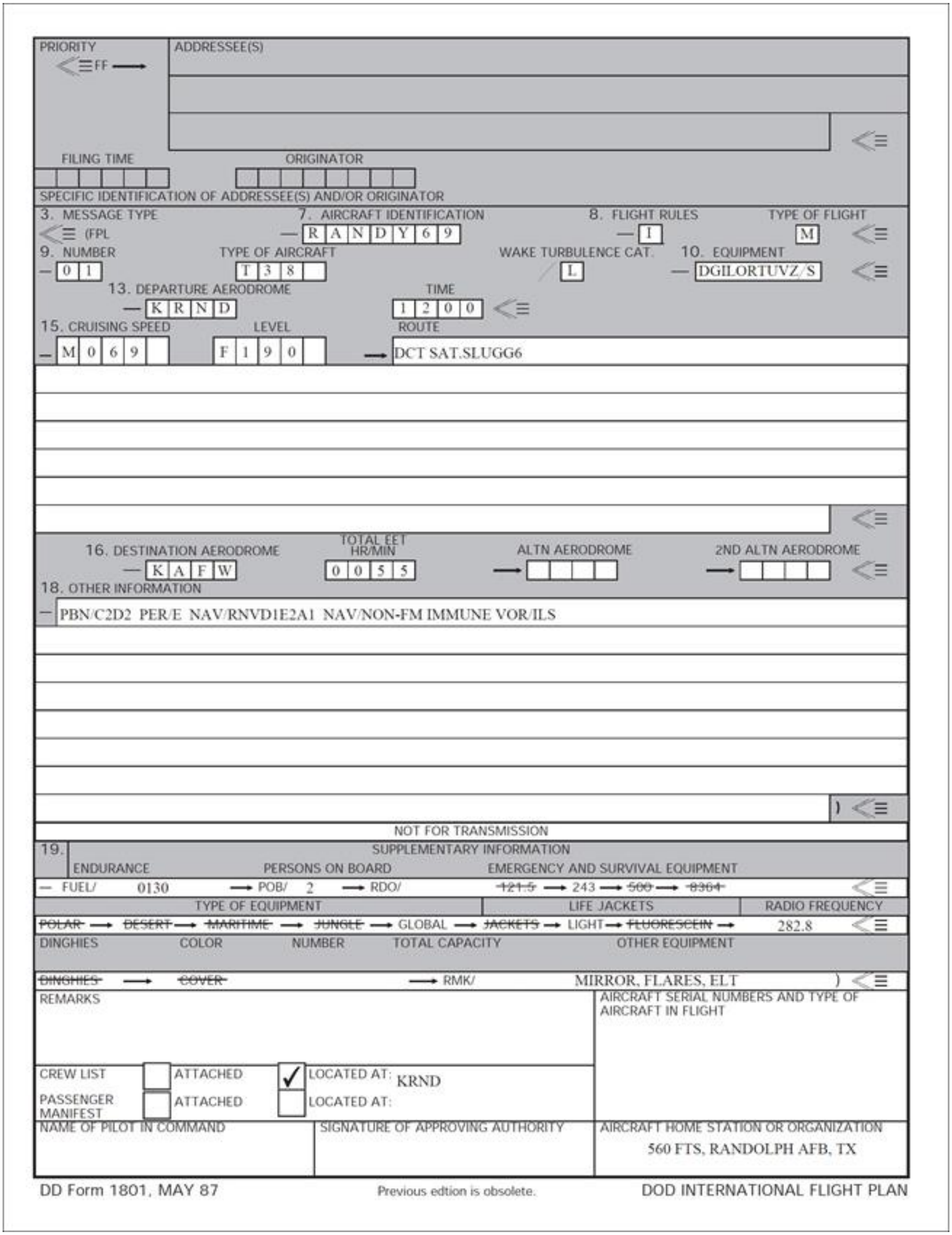
7.18.6.2. Pilots are required to file a DD FORM 1801 for RNAV routing in domestic airspace including RNAV SIDs and STRs. Refer to FLIP GP for general instructions on completing a DD Form 1801. See **Table 7.4** for T-38C specifics. See **Figure 7.2** for example.

Table 7.4. T-38C Specifics for DD1801.

Section	Block	Input	Remarks
7	Aircraft Identification	Call Sign	
8	Flight Rules	I	Filing IFR
	Type of Flight	M	Military Aircraft
9	Number	A/R	Number of Aircraft in flight
	Type of Aircraft	T38	
10	Equipment	DGILORTUVZ	DME, GNSS, INS, ILS, VOR, PBN, TAC, UHF, VHF, Other
	Transponder	S	
15	Cruising Speed	M0XX or NXXXX	M for Mach, N for Knots
	Level	F190	F = Flight Level

			A = Altitude in hundreds of feet
	Route	As desired	
18	Other Information	PBN/C2D2 PER/E NAV/RNVD1E2A1 NAV/NON-FM IMMUNE VOR/ILS STS/NONRVSM (optional)	
19	Survival Equipment	To indicate your survival equipment, cross out 121.5, 500, 8364, Polar, Desert, Maritime, Jungle, Global, Fluorescent (Jackets/Light are pilot dependent) and write 282.8 under radio frequency. Cross out dinghies unless you have a raft.	

Figure 7.2. Example DD1801.



PRIORITY ADDRESSEE(S)
<≡FF →
<≡
FILING TIME ORIGINATOR
SPECIFIC IDENTIFICATION OF ADDRESSEE(S) AND/OR ORIGINATOR
3. MESSAGE TYPE 7. AIRCRAFT IDENTIFICATION 8. FLIGHT RULES TYPE OF FLIGHT
<≡ (FPL — R A N D Y 6 9 — I M <≡
9. NUMBER TYPE OF AIRCRAFT WAKE TURBULENCE CAT. 10. EQUIPMENT
— 0 1 T 3 8 / L — DGILORTUVZ/S <≡
13. DEPARTURE AERODROME TIME
— K R N D 1 2 0 0 <≡
15. CRUISING SPEED LEVEL ROUTE
— M 0 6 9 F 1 9 0 → DCT SAT.SLUGG6
<≡
16. DESTINATION AERODROME TOTAL EET HR/MIN ALTN AERODROME 2ND ALTN AERODROME
— K A F W 0 0 5 5 → → <≡
18. OTHER INFORMATION
— PBN/C2D2 PER/E NAV/RNVD1E2A1 NAV/NON-FM IMMUNE VOR/ILS
) <≡
NOT FOR TRANSMISSION
19. SUPPLEMENTARY INFORMATION
ENDURANCE PERSONS ON BOARD EMERGENCY AND SURVIVAL EQUIPMENT
— FUEL/ 0130 → POB/ 2 → RDO/ ~~121.5~~ → 243 → ~~500~~ → ~~8364~~ <≡
TYPE OF EQUIPMENT LIFE JACKETS RADIO FREQUENCY
~~POLAR~~ → ~~DESERT~~ → ~~MARITIME~~ → ~~JUNGLE~~ → GLOBAL → ~~JACKETS~~ → LIGHT → ~~FLUORESCEIN~~ → 282.8 <≡
DINGHIES COLOR NUMBER TOTAL CAPACITY OTHER EQUIPMENT
~~DINGHIES~~ → ~~COVER~~ → RMK/ MIRROR, FLARES, ELT) <≡
REMARKS
AIRCRAFT SERIAL NUMBERS AND TYPE OF AIRCRAFT IN FLIGHT
CREW LIST ATTACHED ✓ LOCATED AT: KRND
PASSENGER MANIFEST ATTACHED LOCATED AT:
NAME OF PILOT IN COMMAND
SIGNATURE OF APPROVING AUTHORITY
AIRCRAFT HOME STATION OR ORGANIZATION
560 FTS, RANDOLPH AFB, TX
DD Form 1801, MAY 87 Previous edtion is obsolete. DOD INTERNATIONAL FLIGHT PLAN

7.18.7. Enroute:

7.18.7.1. Q/T routes (high/low) are designed for RNAV operations and the T-38C must comply with specific requirements in FAA AC90-100A. ***When RNAV Q and T routes are flown, pilots will:***

7.18.7.1.1. ***Load the route points as FBY (default) in a conventional flight plan (0-9)***

7.18.7.1.2. ***Use automatic waypoint (WP) sequencing***

7.18.7.1.3. ***Set CDI sensitivity to* 2 *NM and remain within full-scale deflection on the route and during turns at WPs***

7.18.7.1.4. ***Select and follow FD indications***

7.18.7.2. When programming Q/T routes into a conventional flight plan, it may be easier to load in reverse order since the adding sequence puts the next WP in front of the previous. While flying a flight plan with an RNAV route loaded, ensure the correct course is selected at the start and the course will automatically change to match charted information.

7.18.8. Departures/Arrivals:

7.18.8.1. Departure Procedures and Standard Terminal Arrival Routes are depicted as SIDs and STARs in DAFIF when loading TERM PROCs. Procedures without RNAV in the FLIP title may be flown using either conventional NAVAIDs or RNAV as long as they are found in DAFIF. ***CDI sensitivity must be set (manually or automatically) to terminal sensitivity. Ensure you manually select CDI sensitivity to TRM (* 1*) if established on a segment of the procedure outside of 30 nm from the procedure-based airfield.*** A good technique to monitor this requirement is to select the procedure-based airfield as your bullseye on the UFCP. Some procedures may be designed with automatic scaling but the pilot must still confirm and manually select if needed. If manual CDI scaling is required, ensure you remember to return the system to automatic once the need for manual override has passed. This is accomplished by inputting 0.0 into the RNP window on the UFCP EGI page.

7.18.8.2. When verifying the database information of a STR with the approach plate, the maximum allowable tolerance between courses is 5 degrees.

7.18.8.3. After loading a TERM PROC SID or STR, sometimes WPs may be deleted if that option is available on the FPL page on the MFD. Typically that option appears on the first and/or last WP to allow the pilot to alter transition routing. It is important to remember if a WP is deleted, you must reload the entire procedure if you subsequently need to utilize that deleted waypoint.

7.18.9. Holding -- RNAV holding uses the same procedures associated with conventional NAVAID holding. However, selecting SUSP is required to prevent auto-sequencing when holding at a WP which is part of a FPL. When holding is complete, deselect SUSP to continue the flight plan as programmed. Most RNAV holding patterns are depicted with leg lengths that are shorter than the T-38's 250-265KCAS and 2 NM turn radius can fly comfortably. Use caution, as significant pilot attention is required to comply with the published procedure. The technique of using a 45-degree teardrop entry will approximate required displacement to intercept inbound course.

7.18.10. Approaches:

7.18.10.1. The original intent of a GPS approach was to transition from the enroute structure to an IAP with minimal communication while maximizing safety and efficiency. The Terminal Arrival Altitude (TAA) helps meet that objective. A TAA is equivalent to a minimum sector altitude on a conventional approach and gives obstacle clearance into the depicted IAF. Additionally, you are expected to descend to the TAA upon procedure clearance and depicted distances from the IAF. These routings are made up of fly-by (FBY) waypoints that provide lead points to fly a charted track. You may need to SUSP on the IAF and set a course in order to proceed direct. In this case, ensure you subsequently deselect SUSP to allow waypoint sequencing.

7.18.10.2. Another method to get to final is via a holding-in-lieu-of procedure turn. First of all, verify Category E minimums are published and that the procedure turn is not prohibited on the approach plate. It is critical to remember to SUSP on the IAF to prevent inadvertent waypoint sequencing. Slow to holding airspeed and determine entry using conventional holding entry techniques. The 80/260 turn reversal technique may be easier to execute than a teardrop entry. Use caution on the turn inbound as the FD may command a turn to a 90 degree intercept heading to the inbound course. For example, the FD could be directing a left turn to achieve that 90 degree intercept, despite the fact that the FAF is to the right of the aircraft. This could cause confusion on a teardrop entry as the FD would be commanding a turn away from the FAWP. It is important to deselect SUSP when the turn is complete and there is sufficient intercept to the desired waypoint. Like holding, these procedures are depicted with shorter than optimal leg lengths for a T-38C and require increased pilot attention to comply with the published procedure.

7.18.10.3. The last method to get to final is via radar vectors. You have the option of loading an IAP procedure via an IAF or Vectors. The vectors option typically drops transition and IAF waypoints to shorten the procedure in the FPL. After the procedure is loaded, typically SUSP on the FAWP and set the final approach course. It may be helpful to SUSP on a waypoint further out on the approach if there is an altitude restriction associated with that waypoint. Pilots should calculate lead turns to maximize situational awareness of when the FD will command a turn to intercept the next segment.

7.18.10.3.1. Selecting SUSP does not prevent the course from automatically changing when the EGI steer point is changed by other than the inc-dec.

7.18.10.4. Unlike a conventional NAVAID approach, distance to the next WP is displayed on an RNAV procedure. This makes it difficult to determine when to descend unless sequencing to that WP. When on an intercept within 90 degrees of final, deselect SUSP to allow proper sequencing past the next waypoint. It is critical to remember, ***when receiving radar vectors to GPS final approach, "established on course" is when you are within one dot (half full scale deflection)***. This is the same as when flying a VOR or TACAN approach.

7.18.11. Final Approach:

7.18.11.1. Final course and distance tolerances may differ by 5 degrees and 0.1 NM respectively and still be flown, and the RNP needs to be 0.3 NM no later than the FAWP.

7.18.11.2. LNAV approach minimums may be lower than LNAV/VNAV minimums. This may be due to TERP requirements of projecting the least desired point and altitude along the course at which the pilot initiates the MAP. To meet departure end obstacle clearance criteria, VNAV minimums are raised to ensure MAP obstacle clearance, thus sometimes greater than LNAV minimums. This certainly makes LNAV/VNAV approaches less effective in low ceiling conditions. However, under certain scenarios, the stable platform from a VNAV descent to landing may be useful.

7.18.11.3. LNAV approaches normally show a visual descent point (VDP) along final which will aim the aircraft at a runway point of intercept coincident with glide path indications. Since the MAWP is normally at the EOR, following the glide path indications places the aircraft at the threshold Crossing Height (TCH) at the MAWP. For this reason, VDPs should normally be re-computed to maximize T-38C available landing distance.

7.18.11.4. If SUSP was used to maneuver the aircraft to final such as during radar vectors, it is critical that it be deselected in order for automatic WP sequencing to continue. SUSP will not prevent APR phase of flight and associated indications, but it will prevent WP sequencing. In this case, the distance will increase from the SUSP WP and the bearing pointer will most likely be behind you. As such, it will be impossible to properly define the MAWP. Any time SUSP is used, ensure you deselect it to continue the TERM PROC.

7.18.11.5. VNAV glidepath indications will appear when steering to the FAWP and within 4 NM, and are similar to an ILS display but will be blue. It is important to note that VNAV is not calibrated like an ILS. An ILS provides a glidepath that funnels the aircraft to landing where a VNAV is a constant slope with one increment above or below equal to 75 feet. Thus glidepath sensitivity remains constant throughout the descent. VNAV guidance should provide clearance from all step down fix altitudes, however, pilots must monitor all step down fixes to ensure compliance. ***Pilots must comply with all step down fixes depicted on the IAP***.

7.18.12. Missed Approach:

7.18.12.1. Performing a missed approach from an RNAV approach utilizes the same procedures as a conventional approach. Should you find yourself reaching a VNAV DA or LNAV MAP, and either the runway is not in sight or you are not in a position to make a safe landing, execute a MAP.

7.18.12.2. However, there are other reasons when flying a RNAV approach that you will be unable to continue the approach. The first is if you do not receive APR sensitivity at 4 NM prior to the FAWP indicated by an Avionics indication and MALF for GPS Approach Not Available. ***Should this occur, attempt to coordinate a new clearance. If this is not possible, do not descend from the FAWP altitude, proceed to the MAWP and execute the MAP***. Another reason to execute a MAP is if you lose RAIM after starting your descent inside the FAWP. ***Should this occur, immediately climb to the MAWP altitude via the MAP instructions***.

7.18.12.2.1. During a MAP, the main objective is safely getting away from the ground. However, after executing the climb, retracting the gear and flaps, and making the radio call; you must manually advance the EGI steerpoint past the MAWP. The TERM PROC is automatically inhibited at the MAWP and requires manual sequencing to display the remaining portion of the procedure and any subsequent TERM PROCs. The NAV Data Block will only display up to the MAWP until you manually sequence past it. Then the NAV Data Block will display the remainder of the MAP and any follow on TERM PROCs if programmed. An important exception is if there is a CA leg. In this case, the waypoint will automatically sequence once the altitude associated with that waypoint is exceeded.

7.19. Circling. ***Circling is accomplished at final turn airspeed with 60 percent flaps. During the instrument final approach, descend no lower than circling MDA for the runway to which the instrument approach is flown. Maintain circling airspeed and 60 percent flaps throughout the entire circling maneuver until aligned with the landing runway. Do not descend below MDA until in a position to place the aircraft on a normal glidepath to the landing runway*.** Once aligned with the landing runway in a safe position to land, slow to final approach airspeed and select full flaps, if desired.

7.19.1. Downwind Displacement:

7.19.1.1. For circling maneuvers requiring a downwind leg, proper displacement from the runway is critical (approximately 1.5 NM). A low circling altitude will make you feel much wider than you are. Attempting to use sight pictures for the normal overhead pattern may cause an overshooting, high-bank angle situation during the turn to final. Do not hesitate to go around if you will need to overbank to prevent an overshoot.

7.19.1.2. Unlike the normal overhead pattern in which a good part of your turn radius is consumed in the vertical, the circling final turn radius is almost entirely absorbed horizontally. The amount of spacing required to complete the turn to final will vary with airspeed (fuel weight), bank angle, and winds. Poor visibility may require you to stay closer to the runway, but do not use a displacement that requires more than 45 degrees of bank to complete the final turn. As a technique, you should plan to practice circling to remain within published visibility minimums.

7.19.2. Downwind Spacing Techniques. The following techniques assist the transition from the instrument approach portion to arrive at a perch with sufficient spacing to complete the final turn. (**Note:** When using any of these techniques, you must correct for winds.)

7.19.2.1. To Circle 180 Degrees or the Opposite Direction:

7.19.2.1.1. Turn 45 degrees away from the runway until you have flown “down” the runway about the same distance as your desired displacement. Then turn to parallel the runway prior to the turn to final. For example, for a 10,000-foot runway, hold the 45-degree offset until approaching the end of the runway in forward runway distance covered. This will build about 10,000 feet of spacing.

7.19.2.1.2. A second option is to perform two 90-degree turns using the desired final turn bank angle— the first to turn perpendicular to the runway, and the second to turn to parallel. Keeping the runway in sight will be more challenging using this technique.

7.19.2.2. To Circle 270 Degrees. Fly past the runway 15 seconds. Then use the desired final turn bank angle to turn downwind. After passing the landing runway, a second option is to turn downwind, using a bank angle with twice the turn radius of your desired final turn bank angle.

7.19.2.3. To Circle 360 Degrees. Consider delaying the initial turn so you can more easily keep most of the runway environment in sight over your shoulder. If you begin a 360-degree circle at the approach end of the landing runway, you will be belly-up to the runway environment and you could lose sight.

7.19.3. Circling Considerations. You must remain vigilant for stall indications and have the discipline to execute a go-around or stall recovery when required. The circling approach presents a potential sink rate problem in the T-38 that may not be accompanied by a stall warning. An overbank during a circling approach creates an insidious descent, which adds to the potential danger.

7.19.4. Unplanned Circling. There may be occasions when you must begin circling from final approach airspeed. For instance, if the runway becomes “wet” during a formation approach, one aircraft may have to circle to land while the other full stops. In these instances, remember to check and reset the flaps to 60 percent and accelerate to final turn airspeed before starting the circle.

7.20. Sidestep:

7.20.1. A sidestep maneuver is a small visual ground track adjustment at the end of a straight-in approach to allow an approach to one runway and a landing on a parallel runway. Where this maneuver is authorized, there may or may not be sidestep procedures or MDAs published on the approach plate. If you are cleared to sidestep where there are no published sidestep MDAs, use circling minimums. Clearance to sidestep will be issued by the tower.

7.20.2. Although sidesteps are not circling maneuvers, one technique is to configure with gear and 60 percent flaps and maintain a minimum of final turn airspeed. In any case, maintain no less than final approach airspeed during the sidestep. You may begin the sidestep maneuver anytime after the landing runway is in sight and inside the FAF. Lower full flaps and slow to final approach speed when aligned with the landing runway in a safe position to land.

7.21. Missed Approach:

7.21.1. Perform a missed approach IAW conditions outlined in AFMAN 11-217, Volume 1, and the flight manual. ***Advance power to MIL, close the speed brakes if open, and raise the nose to 5 degrees above the last known level-flight pitch attitude. With a positive climb established on the altimeter and the vertical velocity reversing, retract the gear and flaps. Accelerate to and maintain 240 to 300 KCAS in a positive climb until reaching missed approach altitude.*** After attaining 240 KCAS, power can be reduced to slow the rate of climb.

7.21.2. ***If a single-engine missed approach is necessary, apply single-engine go-around boldface.*** Use extreme caution in attempting to attain 5 degrees above the last known level-flight pitch attitude. If the ability to maintain airspeed, positive climb, and terrain clearance is in question, consider ejection.

7.21.3. For circling approaches, if the runway environment is not in sight at the missed approach point, execute the verbally issued climb out instructions or published missed approach. ***If the circling maneuver has been started and the airport environment is visually lost, perform a missed approach for the runway to which the approach was flown IAW AFMAN 11-217, Volume 1.***

Chapter 8

NAVIGATION

8.1. Introduction. The purpose of navigation is to get from point A to point B. Whether accomplished on a cross-country mission or used to find a target, navigation requires significant preflight planning. Planning a navigation sortie requires you to consider many factors—runway length, barriers, servicing availability, airfield operating hours, etc.—taken for granted at the home field.

8.2. Preflight Planning. Prior to departing on any off-station mission, familiarize yourself with the strange-field procedures located in applicable *FLIP* guidance and Section II of the flight manual. Throughout all your planning, be very careful to use accurate local or Zulu time, as appropriate. Before starting detailed mission planning, verify the following basic requirements:

8.2.1. Ensure your arrival and departure fall inside operating hours for the airfield and the transient alert or servicing fixed base operator (FBO).

8.2.2. Make a preliminary check of the weather, winds, notices to airmen (NOTAM), and airfield suitability and restriction report for showstoppers, like runway closures, winds out of limits, or forecasts below minimums.

8.2.3. Call your destination to ensure you can go there, get proper servicing, have a place to stay (if applicable), and depart on schedule. If necessary, obtain a prior permission required number. While you have the destination station on the phone, ask about the landing runway, multiple approach availability, serviceability of the start cart (has it been started and used recently?), and any unusual procedures or facility changes that are not in the NOTAMs. Variations in off-station pressure altitude, temperature, and runway length could result in TOLD numbers significantly different from typical home field computations. Where the combination of pressure altitude and temperature might be a factor, ensure the TOLD at the out base will not prohibit your departure.

8.3. Single-Engine Planning. Due to the performance limitations of the T-38 during single-engine situations, departures require detailed planning IAW current MAJCOM and subordinate guidance to meet AFI 11-202, Volume 3, requirements.

8.4. Planning an IFR Navigation Mission:

8.4.1. Weather and Winds. The weather and winds determine if you can takeoff; where, how far, and (perhaps) how high you can fly enroute; whether you can land at your destination; and if an alternate is required. Prior to the detailed planning, check the following:

8.4.1.1. Departure, enroute, destination, and drop-in weather—observation and forecast.

8.4.1.2. Climb and cruise winds, Delta-T, and temperature at altitude for each leg.

8.4.1.3. Surface winds at each base.

8.4.1.4. Possible hazards—icing, thunderstorms, etc.

8.4.2. Routing. Look at the high or low charts to determine the most suitable route of flight. Consider any hazards, no-fly areas, MOAs, standard terminal arrival routes (STAR), and preferred routing. Failure to consider these can cause lengthy delays or changes to your planned flight route.

8.4.3. Distance. Make sure your planned leg lengths provide you with enough fuel to complete training objectives and land with a buffer above minimum fuel. Planning to arrive at your destination with minimum fuel will greatly reduce your options if you experience any delays or—worst case—if you need to divert. Headwinds and tailwinds are often significant factors. If your plan requires the use of reduced visual separation measures (RVSM) airspace, you will need a suitable alternate that does not require access to RVSM airspace (reference AFI 11-202, Volume 2). Some techniques for leg-length decision making are as follows:

8.4.3.1. High altitude, no wind, no drop-in, no pod, one approach to full stop—approximately 700 NM max.

8.4.3.2. High altitude, some wind, no drop-in, pod or clean, one approach—approximately 500 NM.

8.4.3.3. Drop-ins with various approach combinations, pod or clean—approximately 300 NM.

8.4.4. Adjustments for the Weapon System Support Pod (WSSP):

8.4.4.1. Flying with the WSSP will cause higher fuel flows due to increased drag. The faster and farther you travel, the greater the fuel effect from a pod.

8.4.4.2. Based on the flight manual's high altitude cruise charts and 11,000 to 12,000 pounds gross weight:

8.4.4.2.1. The WSSP will increase fuel consumption by about 125 pph per engine at FL 250 and 0.75 Mach. Depending on climb, descent, approach, and distance requirements, a reasonable technique would be to plan for using an additional 150 to 200 pounds for these scenarios.

8.4.4.2.2. The WSSP will increase fuel consumption by about 220 pph per engine at FL 350 and 0.9 Mach. Depending on climb, descent, approach, and distance requirements, a reasonable technique would be to plan for using an additional 250 to 300 pounds for these scenarios.

8.4.5. Cruising Altitude. Select cruising altitudes and airspeeds consistent with mission requirements, applicable directives, and safety. RVSM restrict your ability to fly above FL 280. The optimum cruise- climb altitude chart in the flight manual provides the best altitude for initial level-off based on fuel weight. The best altitude for fuel economy will increase as gross weight decreases. However, due to the need to fly at higher Mach, the susceptibility of the J-85 engines to flameouts and compressor stalls and the inefficiency of the PMP modified engines at higher altitudes virtually negate any fuel consumption advantage at higher altitudes. At or above FL 280, the min Mach (MM) caret will appear on the airspeed indicator in the MFD. MM is the minimum speed to cruise for the altitude corresponding to the black stripe region for the altitude and temperature conditions.

8.4.6. AF IMT 70, Pilot's Flight Plan and Flight Log. Although it can be very useful in many ways, the AF IMT 70 is primarily a fuel-planning template. You must do enough fuel planning to ensure mission safety. Beyond that, filling out an AF IMT 70 is left entirely to pilot technique.

8.4.7. DD Form 175/1801, Military Flight Plan. ***Air Force pilots are required to file a flight plan (FPL) for all flights.*** After completing the AF IMT 70, fill out the DD Form 175 or 1801 as appropriate according to *FLIP General Planning* and **paragraph 7.18** of this manual.

8.4.8. Destination Review. Note obstacles, airfield layout, barriers, approach lighting, type of visual glidepath guidance, field elevation, runway data, important frequencies, for your destination and any possible enroute or destination divert options.

8.5. Planning a VFR Navigation Mission. Maintaining SA will be different on a VFR mission because, although you have fewer distractions from ATC, you also receive less information. This affects the way you plan the mission and the tasks you perform while airborne.

8.5.1. Weather and Winds. VFR conditions do not necessarily mean the absence of clouds. *The pilot is responsible for determining that VFR conditions and cloud clearances can be maintained for the entire proposed route of flight.*

8.5.2. Map Selection. Choose an operational navigation chart (ONC) or tactical pilotage chart (TPC) based on the desired level of detail. As a technique, use an ONC when flying above 6,000 feet AGL and a TPC when flying below. A joint operations graphic (JOG) chart may be used for detailed route study and preflight planning. World aeronautical charts (WAC) and sectional charts are the same scale as ONC and TPC respectively and include airspace boundaries and frequencies.

8.5.3. Map Preparation. There is a wealth of information you may choose to put on your VFR map. You may want to highlight emergency airfields, VORTAC stations, tower frequencies, etc. Additionally, you need to mark turn points, courses, headings, checkpoints, obstacle elevations, etc., for your route. You will need to plan for a specific GS and make tick marks for timing. You may run either a continuous clock or individual leg times. Other handy information would include Class B, C, and D airspace boundaries and frequencies, conflicting airways, air route traffic control center (ARTCC) sector frequencies, and planned fuels. Flight planning software specified by your MAJCOM provides excellent tools for preparing and printing VFR maps. Once you receive appropriate training in the use of the planning software, the time spent preparing your VFR map will be significantly less than if you did it manually.

8.5.4. Routing. You must do enough research on special use airspace, victor airways, and Class B, C, and D airspace to avoid them. Don't forget to consult the temporary flight restrictions (TFR) NOTAMs to identify any temporary airspace restrictions along your route of flight. Use very prominent features that you could still navigate by despite potential low scattered clouds when selecting turn points.

8.5.5. Distance. When determining the length of a VFR leg, consider the altitude you plan to fly and the winds at altitude. VFR legs between 250 and 350 nm work well, with or without a travel pod. This will allow you fuel for several overhead patterns or the option of coordinating for practice instrument approaches after your VFR arrival. As a guide, do not plan a VFR leg greater than 400 nm.

8.5.6. AF IMT 70 for VFR Missions. If all pertinent information—including fuel requirements—is on your VFR map, an AF IMT 70 is not required for the portion of the VFR mission covered by the map. Measure headings and distances directly from the VFR map.

Compute your GS by using the forecast winds, and use it to determine the total time enroute and fuel required. As a technique, include all information you'll need for the VFR arrival (frequencies, pattern altitudes, etc.) on your map.

8.5.7. DD Form 175 for VFR Missions. The Route of Flight block on the DD Form 175 should include enough information to allow search and rescue operations to trace your flightpath. You may use any of the following: names of cities and towns, prominent landmarks or bodies of water, VORTAC radial and DME, latitude and longitude, or VFR reporting points.

8.6. Preflight Ground Operations:

8.6.1. Logistics. As many pilots have discovered over the years, being without necessary equipment, paperwork, or supplies can seriously degrade your cross-country experience. Maintenance should help you launch with tires and aircraft inspections that will last for the duration of the cross-country flight. In addition to personal baggage, before launching from any home station or out base, consider including the following "don't leave without it" items: (**Note:** These are not all-inclusive.)

8.6.1.1. Required low and high enroute charts.

8.6.1.2. Required approach plates and STARs.

8.6.1.3. Low-level and VFR maps.

8.6.1.4. Instrument hood.

8.6.1.5. Aircraft forms (AFTO Form 781-series).

8.6.1.6. Civilian and military fuel cards.

8.6.1.7. Fuel receipts.

8.6.1.8. Intake, exhaust, and HUD covers.

8.6.1.9. AOA vane lock.

8.6.1.10. Grounding wire.

8.6.1.11. Flashlights and clear visors.

8.6.1.12. Data transfer cartridge and VTR tape(s).

8.6.2. Transient Alert or FBO Ground Crews. Ensure transient alert FBO personnel are familiar with starting and post-start procedures. Become familiar with how to operate the manual diverter valve in case you need to explain its operation. Strange Field Procedures of the 1-T-38C-1CL-1 checklist provides T-38C compatible oil, fuel, oxygen, hydraulic, and air starting unit information.

8.6.3. Getting Clearance. Prior to engine start, determine the status of your clearance with clearance delivery or ground control. If you anticipate any delay, consider postponing engine start until receiving your clearance. Be sure you can comply with any differences between your received clearance and your planned route of flight. For VFR flights, local directives and good sense may require you to ask for a squawk for flight following.

8.6.4. Cockpit Organization. Cockpit organization is very important. Arrange your publications so you can get to everything without cluttering up the cockpit. Arrange publications in the map case in the order you will likely use them. More than for other types of missions, you will need a place to write on short notice, so put your cards, AF IMT 70, and kneeboard near your writing hand. Do not have any publications loose with the canopy open.

8.7. Departure:

8.7.1. Departing from a Non-military Airfield***. When departing from a nonmilitary field and not filling a flight plan or activating a flight plan, you must contact the nearest flight service station (FSS) or coordinate through tower with your actual departure time so you do not arrive unannounced at your destination.***

8.7.2. Departing VFR. ***After you are cleared for takeoff, squawk "1200" and remain on tower frequency until you depart their airspace. If departing an airfield that lies within Class B or C airspace, you must contact departure control after takeoff***. Until you exit ATC airspace, comply with any instructions (headings, altitudes, squawks, etc.) issued by ATC. ***If you depart from a civilian field, you will need to contact the nearest FSS on*** **255.4** ***or*** **local VHF FSS frequency** ***to activate your FPL. You are responsible for maintaining VFR cloud clearances.*** Once you leave tower frequency, you have two options:

8.7.2.1. VFR Option Number 1. Contact ATC for flight following. Squawk the assigned code (if other than 1200), and fly requested altitudes if weather allows. ATC will provide you with traffic advisories as time permits, but you must aggressively clear at all times. You will be passed from controller to controller as you proceed along your route.

8.7.2.2. VFR Option Number 2. You may remain on 255.4 or the VHF FSS frequency for the entire route of flight. If you choose this option, contact subsequent FSSs as your sortie progresses. Remember to set the local altimeter at least every 100 NM.

8.8. Enroute IFR and VFR:

8.8.1. Airspeed. When flying at high altitude, maintain an IMN appropriate for the engine envelope. The flight manual checklist's Engine Compressor Stall/Flameout Susceptibility chart specifies a minimum IMN for a given altitude and temperature. Anything that induces turbulence or interrupts airflow, such as bank, yaw, or abrupt throttle movement, can increase susceptibility to flameout or compressor stall.

8.8.2. Groundspeed (GS) Check. Once stabilized at your planned cruise airspeed, compare your actual GS to the planned GS to determine the effect of the actual winds and how they might impact fuel planning.

8.8.3. Waypoint Checks. As you pass your planned waypoints, compare your actual fuel and flight time to those you planned.

8.8.4. Flight Plan and Route of Flight Adjustments. Unusual ground delays, low altitude step-up restrictions, and (or) unforecast headwind velocity could place you in a potentially fuel-deficient situation. Apply any significant differences between planned GS and (or) fuel remaining to the remaining route of flight and modify your FPL, if necessary. In a worst-case situation, you may have to divert to a suitable airfield short of your destination. The emergency divert mode of the EGI can be helpful in determining fuel remaining at the destination.

8.8.5. Lead Points:

8.8.5.1. When flying on published jet routes or airways, remaining within the protected airspace requires the use of good lead points during turns to new courses. The most mathematically unusual situation occurs when making a significant turn over a VORTAC waypoint because the cone of confusion will begin at a rather large slant-range DME. The technique (Mach minus 2) will give you the correct lead point in NM, but triangle hypotenuse math is required to turn it into a useable, close-to-the-station DME.

8.8.5.2. The following is an easier technique to calculate no-wind DME lead points for 30-degree bank turns at normal cruising airspeeds or altitudes: lead point equals 1 NM for each 30 degrees of turn plus altitude in NM above the station. For example, approaching a VORTAC at FL 360, you would be turning from a 270-degree inbound course to a 330-degree outbound course. For this 60-degree turn, you would take 2 NM (1 NM for every 30 degree of turn) and add 6 (your altitude in NM). Your lead point would be approximately 8 DME.

8.8.6. Radio Frequencies. Maintain a record of assigned frequencies in case you are sent to a bad frequency and must re-contact the last controller.

8.8.7. Positional Awareness. Because a radio or NAVAID failure can occur at any time, maintain constant positional awareness through the use of NAVAIDs, map reading, and dead reckoning (DR).

8.8.8. Weather and Winds. Check the weather far enough out (80 to 120 NM) so you can be thoroughly prepared for your arrival as well as any unexpected changes or diverts. In addition to checking destination or drop-in weather, you may want to check the weather at your planned alternate. If you have time and (or) are queried by a pilot to metro service (PMSV) forecaster, make a pilot report (PIREP). (The format is in the *Flight Information Handbook [FIH]*.) To obtain destination, drop-in, or alternate weather and winds enroute, there are several options:

8.8.8.1. Automated Terminal Information Service (ATIS). This is the easiest and quickest option but not always a reliable one. Some ATIS messages are less complete and less frequently updated than others, especially on weekends. Listen for the time group to see how old the information is and make decisions accordingly. Note the letter identifier for your check-in with approach control.

8.8.8.2. PMSV. If the weather is poor, PMSV is usually a better source of updated information if it is available. The information provided should be current; you can talk to a forecaster if needed; and you can ask real-time questions about trends, actual thunderstorm activity, divert options, etc.

8.8.8.3. Approach or Tower. Consider this option if: (1) you are unable to receive ATIS or contact PMSV, or (2) you are arriving at a civilian field with no ATIS. Use discretion on what could be a busy frequency. A quick request for the landing runway and current observation will give you enough information to make initial decisions.

8.8.8.4. SOF. At military fields, the SOF on duty can be an excellent option in lieu of ATIS or PMSV. In fact, in certain circumstances (timing of exercises, ceremonial events, FBYs, etc.), talking to the SOF may be highly preferred.

8.8.8.5. FSS. Contact an FSS on frequency 255.4 or 122.2, using the callsign "radio" (for example: ("Greenwood radio"). FSSs contain reliable, full-service teams, complete with PIREP information, when it's been provided.

8.8.8.6. Automated Weather Observation System (AWOS). Many civilian fields are modernizing their weather service by installing automated weather equipment to provide timely and accurate surface weather conditions to pilots, ATCs, other aviation users, and the national weather data network. AWOS provides an automated and continuous real-time weather reporting system that transmits weather data to both airport personnel and aircraft via VHF radio. AWOS collects and transmits data on wind direction and speed, altitude, density altitude, temperature, dew point, and relative humidity. It may also report cloud heights and thunderstorm activity.

8.8.8.7. Hazardous Inflight Weather Advisory Service (HIWAS). HIWAS is available through selected VORs across the country. It is a continuous broadcast of hazardous weather similar to an ATIS broadcast for an airfield. To listen, tune the selected VOR, select VOR as the NAV source, select VI on the ACP and turn up the volume.

8.8.9. VFR Altitudes Enroute. Fly appropriate VFR altitudes according to *FLIP*. Assuming you have the weather and have cleared carefully, you may change your altitude at any time during the flight. You do not need permission to alter your altitude, but you should inform the controlling agency of your intentions if you are getting flight following service. In formation, all flight members should be at an appropriate VFR altitude.

8.8.10. Encountering Unexpected Weather While VFR Enroute. If you encounter unexpected weather, you have the following three options:

8.8.10.1. Alter Route of Flight and Continue. You may alter your route and (or) altitude to avoid unexpected weather, but you must continue to maintain the required VFR cloud clearance and visibility requirements. Ensure your fuel allows any deviations from the plan. Inform FSS personnel of any major route changes and pass them a PIREP describing the unexpected weather.

8.8.10.2. Return to Base of Origin or Divert. If you have not proceeded far from your departure field, turning around and returning there may be the best option. If you are significantly down track on the route, proceeding to an alternate airfield may be preferred. In either case, maintain VFR conditions and ensure sufficient fuel exists. Inform FSS personnel of route or destination changes; give them a PIREP; and obtain the NOTAMs for your new destination.

8.8.10.3. Pick Up an IFR Clearance. Contact an FSS or controlling agency to file an IFR clearance. (ARTCC frequencies can be found on *FLIP* low altitude enroute charts). Until your IFR clearance is activated, you must maintain VFR conditions. Picking up an IFR clearance while airborne is really quite simple but requires some preparation. You will be required to provide the same type information that you would use on a DD Form 175/1801. Use the sequence on the back cover of the IFR enroute supplement to help you organize and provide the right information.

8.9. VFR Lost Procedures. First, use every possible resource to regain positional awareness. Use EGI steering to determine the course to a known point. Use your lat/long present position on the MFD EGI display page or radial/DME from a known NAVAID to plot your position onto your VFR map. If the DME is inoperative, attempt to identify your location by cross-tuning radials from two different NAVAIDs. If, after using every possible resource for positional awareness you still cannot determine your position, follow this habit pattern:

8.9.1. Climb—Conserve—Confess:

8.9.1.1. Climb. For fuel conservation, climb to the highest possible altitude below FL 180 where you can maintain VFR.

8.9.1.2. Conserve. Establish the maximum endurance airspeed for your fuel weight (230 KCAS + total fuel). Another technique is to use the Endurance (ENDR) profile in the Emergency Divert Mode and fly the commanded CAS/IMN for your current altitude. BNGO in the Emergency Divert Mode display block on the MFD also provides you with time to reach your selected Bingo fuel under current conditions when operating in the ENDR profile.

8.9.1.3. Confess:

8.9.1.3.1. Call for help. Admitting you are lost and getting help is far better than delaying until you are low on fuel. Start with appropriate ARTCC and approach frequencies (try several if necessary), but do not hesitate to use guard frequency. For guard calls, preface the call with "mayday, mayday, mayday," give your callsign, and request help from any agency hearing the transmission.

8.9.1.3.2. A number of controlling agencies will probably answer your distress call. Select one and direct the rest to remain silent. Select Emergency on the identification, friend or foe/selective identification feature (IFF/SIF) using the UFCP or set code 7700 in Mode 3/A. When the Emergency function is selected, the IFF/SIF IDENT feature will not be available, so consider entering 7700 into the Mode 3/A instead. The controlling agency can give you heading and distance information to the nearest suitable airfield, your home field, or your destination.

8.9.1.4. Check the Compass. Ensure your EHSI is operating properly and compare it to the standby magnetic compass.

8.9.1.5. Without Radio Contact. Attempt to pick out a prominent landmark on the ground—a body of water, a town, a large airport, or a railroad crossing are all good landmarks. Try to orient your map with the selected landmark. If you cannot locate the landmark on your map, do not wander aimlessly. Fly a definite heading until you can identify a good landmark.

8.10. IFR Arrival:

8.10.1. Descent from High Altitude. Consider preheating the canopies with the canopy defog because descents into warmer, humid air may cause the canopies to fog up.

8.10.2. Clearances. There are at least three clearances requiring careful attention during any arrival:

8.10.2.1. IAF or Beginning Enroute Descent. Before arriving at an IAF or holding fix, or before beginning an enroute descent, know your clearances and any restrictions. These often include holding instructions, approach clearance, clearance to use maneuvering airspace, expect further clearance times, enroute descent instructions, etc. This is especially important when on an enroute descent in the event of radio failure.

8.10.2.2. Missed Approach or Climbout. Before the FAF, coordinate climb out, missed approach, alternate missed approach, and (or) departure instructions, as appropriate. Write them down!

8.10.2.3. Landing. Passing the FAF, ensure you know your clearances and restrictions; for example, proper runway, low approach, land, touch-and-go, option, sidestep, circling, restricted low approach, etc.

8.11. VFR Arrival on an IFR Flight Plan. If flying in Class A airspace or in IMC, coordinate with the enroute ARTCC for a descent to VFR conditions below the Class A airspace. Cancel IFR when able to maintain VFR, and navigate to the airfield using a VFR map and NAVAIDs. Clear visually and over the radios. Coordinate with ATC to proceed VFR-to-initial or to a visual straight-in. When practical, remain on ATC frequency for traffic advisories.

8.12. VFR Arrival at an Unfamiliar Field:

8.12.1. Coordination. Know the classes of airspace affecting your VFR arrival. These may be obtained from *FLIP AP/1* or the IFR enroute supplement. You must abide by these airspace rules even when VFR. Approximately 40 NM out, you should check the weather and current runway (ATIS, if available). Approximately 30 NM out, contact ATC and request the VFR arrival.

8.12.2. VFR to Initial. You should plan on a 3 to 5-mile initial. To maintain positional awareness approaching airports with several offset or crossing runways, keep SA on your inbound bearing to the field and your current heading comparing them to an airport diagram. Setting the runway heading for the heading set marker or the course window on the MFD is a familiar way to visualize the pattern for the correct runway. The IFR enroute supplement normally indicates the pattern altitude and direction of break, but listen carefully for modified instructions and other guidance like wake turbulence, runways, type landing, etc. Clear for other aircraft or helicopters, stay aware of wake turbulence separation, and be vigilant for degraded aircraft performance at high density altitudes.

8.12.3. Visual Illusions. Use caution when landing on unfamiliar runways. Start with a careful study of the airport diagram and the IFR enroute supplement so you know what to expect. Plan for how you might adapt to a runway without an overrun or one with a displaced threshold. Remember that a wider runway may contribute to a high flare and a long or dropped-in landing, while a narrower runway may lead to an incomplete flare and early landing. Usually a wider runway will have side stripe markings approximately 150 to 200 feet wide to help with depth perception. Use all available references to determine your height above the runway. As a technique, transition your eyes to the departure end of the runway during the flare to help gauge your height above the runway.

8.13. Off-Station, Post-flight Ground Operations:

8.13.1. Canopy Management and FOD. With so many items potentially cluttering the cockpit during a cross-country mission, you may want to leave the canopies closed until engine shutdown. In any case, double-check to ensure all loose items are accounted for and secure before opening the canopies.

8.13.2. Taxiing on a Strange Field. Although you can request progressive taxi from the ground or tower controller, you can maintain higher SA by referencing the airport diagram and signs posted along your taxi route. With a little prior study, you can often anticipate your taxi route and parking area. Many civilian and military transient operations use a "follow-me" vehicle as well. If desired to expedite your next leg, accomplishing a stored heading alignment once in parking and prior to engine shutdown can reduce your alignment time to 1.5 minutes or less.

8.13.3. Closing Flight Plans. Normally, there is no need to close an IFR FPL with the FSS. The tower should do this for you at a military or civilian field. However, because some civilian fields are not as reliable as others in always closing your IFR FPL, it is usually wise to verify with the FSS or tower that it has been closed. Remember, IAW AFI 11-202, Volume 3, ***you are responsible for closing a VFR FPL with FSS.***

8.13.4. After Engine Shutdown. Refer to the checklist and other appropriate items in your inflight guide. Conduct a thorough post-flight inspection of the aircraft, and ensure transient alert personnel are familiar with the T-38's servicing requirements. Also, ensure they properly secure, pin, and ground the aircraft. Ensure you are familiar with alternate fuel procedures, if applicable. Complete all required paperwork. When possible, give transient alert a phone number where you can be reached, even if it is the billeting number. You are ultimately responsible for your aircraft until it returns to the home station.

8.13.5. Stopovers. As a technique, the following acronym—WANTS—will help you remember what to accomplish at a stopover location:

8.13.5.1. **W** eather, winds, temperatures, bird status.

8.13.5.2. **A** ctivate flight plan or **A**lternates and emergency fields.

8.13.5.3. **N** OTAMs.

8.13.5.4. **T** OLD.

8.13.5.5. **S** ID or departure instructions. Call the **S**UP, **S**OF, or command post.

Chapter 9

LOW-LEVEL NAVIGATION

Section 9A—Purpose

9.1. Introduction. The purpose of low-level navigation is to fly a preplanned ground track to a designated target so as to arrive at a designated time over target (TOT) or time to target (TTT). Flying high-performance jet aircraft on low-level missions puts you close to the ground at high speed. Your close proximity to the ground increases the risk. In addition to the ground, other threats include aircraft, birds, and obstacles. Therefore, your margin for error and your time to react are significantly reduced. The intent of low-level training in the T-38 is to provide the basic foundation from which to build as you transition into the Combat Air Force (CAF). Each low-level will be broken down into mission planning, briefing, and flying phases.

Section 9B—Mission Planning

9.2. Overview. The first step in preparing for the mission is becoming completely familiar with the route requirements and any associated restrictions. Consider referencing a sectional chart to determine national airspace restrictions. Applicable publications include FLIP General Planning (GP), AP/1B Manuals, the Chart Update Manual (CHUM), and command and local guidance. Low-level routes and corridors can be loaded in the DTC during mission planning for use in flight if desired and IAW training requirements.

9.3. Military Training Route (MTR) Selection:

9.3.1. In the United States, military low-level training is conducted in designated airspace as outlined in Federal Aviation Administration (FAA) publication 7610.4, Special Military Operations. Use FLIP AP/1B as the primary reference for MTR selection. The slow routes (SR) are not used by T-38s due to airspeed restrictions.

9.3.2. When selecting a route, identify your departure and recovery bases and find a route nearby. In many cases, the instrument routes (IR) and visual routes (VR) described in FLIP AP/1B are too long to successfully fly from the primary entry to the primary exit. Therefore, alternate entry or exit (or both) may have to be used. Route selection should be made so navigation to the desired entry, flying the route, and recovery to the desired destination can be completed within the T-38's fuel limitations.

9.3.3. For initial fuel planning, approximately 45 pounds per minute at 360 knots GS (6 NM per minute) works while on the low-level. (For example, in 40 minutes, 240 NM of low-level will use approximately 1,800 pounds of fuel.) The longer the planned low-level, the less fuel remaining for navigation to and from the route, and therefore, the closer the route needs to be to the planned departure or recovery base. Additionally, ensure the enroute and on-route weather will allow you to fly the selected low-level. Refer to AP/1B for the VR route weather minimums and AFI 11-2T-38, Volume 3, for the IR route weather minimums.

9.4. Map Preparation. ***On low-level missions, each pilot must carry a current map of the route.*** Refer to map preparation requirements in AFI 11-2T-38, Volume 3, and any command or local supplements.

9.4.1. Map Selection. For sufficient detail and quality of terrain features, a published TPC (1:500,000 scale) or a chart generated from flight planning software should be used. With greater detail, JOGs can be excellent for low-level missions. However, they can be cumbersome because of their size. For low-level routes flown with TPCs, you may want to carry JOG sections of the turn points and the target areas. You may also find JOGs especially useful for detailed route study during preflight planning.

9.4.2. MTR Corridor:

9.4.2.1. Draw the MTR corridor from the planned entry point to the planned exit point, using the latitude-longitude of the published waypoints and designated route corridor lateral displacements. Additionally, make annotations for the vertical limits of the route segments. ***Update the chart with the latest information from the CHUM (hard copy or electronic) to include all the area within the route corridor and any significant obstacles outside the route corridor that could be a hazard to the flight***. This step is imperative for flight safety and may be completed using approved flight planning software.

9.4.2.2. Study the route enough to gain an initial feel for all obstacles and terrain features at or above planned flight altitude. Highlight any obstacles or high-terrain features that may be a factor along your route of flight using appropriate thin-line "bubbles." One technique is to use 2- to 3-mile bubbles to mark decision making points for those obstacles not acquired visually.

9.4.2.3. Lastly, use the appropriate sectional chart to determine all crossing MTRs. **Note:** Sectional charts do not show SR.

9.4.3. Emergency Route Abort Planning. ***Compute the emergency route abort altitude (ERAA) IAW AFMAN 11-217.*** Route abort frequencies can be obtained from the "postage stamps" on *FLIP* low charts. Highlight the map with emergency or alternate airfield locations and information such as VORTAC channels and tower and approach frequencies.

9.5. Route Development. As a minimum, you will need a route entry point, a high-confidence "hack" point for your clock or timer, recognizable turn points, a clearly discernible initial point (IP), and an appropriate target. The best features for turn points are usually natural because these features change very little over time. You may also use manmade features such as bridges, road intersections, and towers. Choose points for their uniqueness, vertical development, funneling features, and surrounding terrain. Avoid using features that may be hidden by high terrain or trees.

9.5.1. Route Entry and Hack Point. Note that your route entry point must be within the route corridor and should correspond with a published entry point (or alternate). An EGI steerpoint is an excellent confirmation of the entry point; however, a VORTAC radial and DME also works well. The hack point can either be the *FLIP*-designated route entry point or down track following an acceleration corridor or route entry corridor. Choose an easily discernible hack point because the first key to good DR is to start from a known point. Do not plan a hack point that requires an immediate turn to remain on course. The hack point is a high-task portion of the sortie. Therefore, minimize maneuvering to ensure a safe and effective route entry.

9.5.2. Turn Points:

9.5.2.1. Draw thin-line circles around turn points to prevent obscuring the surrounding details. When choosing turn points, consider the turn radius of the T-38 at your planned GS and the type of turn you will be using. Avoid choosing points so close to the corridor edge that your planned turn radius will not allow you to stay within the corridor. Use a tactical plotter or planning software to plot the turn radius based on starting turns right over the turn points.

9.5.2.2. There are two common choices for low-level turns. One choice is a hard (4 G) turn, similar to the kind used in tactical formation. Use approximately 1 NM for a turn radius for these hard turns. A second choice is a 55- to 60-degree bank, 2 G turn. This turn matches the 55-degree bank turn radius circle on most tactical plotters.

9.5.2.3. If planning a route using flight planning software, ensure the programmed profile reflects the method you will use to fly the route; otherwise, timing errors will be induced on the low-level. For example, if the flight plan reflects 45-degree bank turns and you use 4 G hard turns, you will find yourself ahead of time on each leg, and anticipated headings will be off by a factor related to the length of the next leg.

9.5.3. IP and Target. Choose an IP located about 1 to 3 minutes prior to the target. An IP should be an easily identifiable point used to fine-tune navigation and increase the probability of target acquisition. Choosing an easily identifiable IP in an advantageous position relative to your target is a good technique since you may not be able to choose your target in follow-on real-world scenarios. Minimize the heading change (up to 30 degrees) at the IP in order to increase the accuracy of the IP-to-target leg. If using a running time, you will normally continue the running time at the IP to the target. If your running time to the target is off, re-hacking at the IP may help you identify the target.

9.5.4. Course Lines, Timing Marks and Mileage Ticks. When drawing course lines between the turn points, use thin lines and be sure to account for the turn radius corresponding to your planned GS and bank angle. Select a GS that easily converts to miles-per-minute, but still allows room for required airspeed corrections. A GS of 360 knots works well at relatively low MSL altitudes to allow an easy conversion to 6 miles per minute. It also permits enough airspeed correction capability to ***maintain above a minimum of 300 KCAS and below a maximum of 420 KCAS (450 KCAS for IFF)***. Place timing tic marks along one side of the route to represent the timing intervals counting up from the hack point. A 1- or 2-minute interval is sufficient. Account for the fact that the IP-to-target run may be planned at a different airspeed. Mileage tics placed along the other side of the route can greatly enhance SA if EGI is used. Using 10 NM intervals for each route leg working back from each turn point is a common technique.

9.5.5. Headings and Drift Corrections. Plot the no-wind headings for each segment of your route and ensure proper application of the magnetic variation. Low-level winds are generally light, not exceeding 15 to 20 knots. However, they can be quite significant under certain weather conditions, such as wind shears, frontal passage, or thunderstorms. Wind direction and speed is available on the MFD on the wind direction and speed display below the right side of the EADI. The arrow indicates the magnetic wind direction. The drift angle and airspeed will change on each leg of the route, depending on the aircraft's heading in relation to the relative wind. You must apply drift correction to maintain course, and you must also adjust airspeed to keep GS constant. Compute and post wind-corrected headings (or correction factor) for each leg of your route. If your planned GS is 6 miles per minute, a simple technique is to apply l degree of drift correction for every 6 knots of crosswind.

9.5.6. Calibrated Airspeed. Use the forecast temperature, pressure altitude, and low-level winds to compute wind-corrected calibrated airspeeds for each leg at the planned GS. To keep GS constant, KCAS should be decreased for a tailwind and increased for a headwind. To simplify airspeed computations, assume there is a one-to-one relationship for increases and decreases in airspeed between calibrated airspeed and GS.

9.5.7. Course Arrow Blocks. The course arrow block is a symbol used to efficiently present the information needed to help you fly the low-level. The course arrow block should include the information pertinent to navigation along the applicable leg of the route which, as a minimum, would include heading, airspeed, and leg time. This emphasizes the core requirements for good DR of time, distance, and heading. Additional information can be added per individual desires, but too much information could become distracting and divert your attention inside the cockpit when it needs to be outside.

9.5.8. Fuel Planning. Compute a planned fuel at designated points along the route***. Refer to the flight manual charts for the required fuel flow. As a technique, a fuel flow of 1,350 pph/engine will normally maintain 350 KCAS.*** Additionally, compute a continuation fuel for the designated points along the route***. Continuation fuel is the minimum required to complete the route at planned speeds and altitudes and RTB with the minimum required fuel reserves. Finally,*** compute and annotate the bingo fuel for RTB by the most practical means from the most distant point on the route***. Consider factors such as cloud ceilings, winds, freezing level, MOAs, VFR hemispheric altitudes, forecast icing, and minimum required fuel reserves.***

9.5.9. Restrictions. ***Highlight and plan to remain clear of any noise-sensitive areas or airfields specifically listed in FLIP AP/1B or local directives***.

9.6. Routing To and From the Low-Level Route. Good route study includes more than the low-level route between the entry point and exit point. Pilots must have a solid understanding of how to get to and return from the MTR. According to *FLIP* AP/1B, flight to and from IR or VR routes should normally be conducted on an IFR FPL. You should normally include the planned route of flight to and from the MTR on your map to include headings, airspeeds, and times. Ensure your planning includes both no-earlier-than and no-later-than takeoff times, which will allow you to enter your low-level on time and also permit completion with the amount of fuel on board.

9.7. Scheduling. Schedule the low-level route for your desired entry time with the scheduling activity as designated in FLIP AP/1B. In instances where there is no published entry timing tolerance window or standard command or local guidance, coordinate an acceptable entry window with the scheduling activity. This becomes important in helping deconflict the route especially with multiple users of dissimilar aircraft. It becomes *most* important on VR routes where ATC is not responsible for the separation of aircraft. Deconflict with crossing routes by calling those routes' scheduling activity in FLIP AP/1B. **Note:** On routes with which you are not familiar or do not routinely fly, it may be beneficial to accomplish this scheduling step early in the planning process to verify there is no unpublished or short-term restriction which would prevent you from flying the route.

9.8. Filing. File for your low-level sortie on a DD Form175, following the procedures outlined in FLIP GP. Annotate your low-level entry and exit times in the Remarks section of the DD Form 175. If flying a local low-level route, the operations personnel at the duty desk typically file your requested local stereo FPL, like for other local mission profiles.

9.9. Map Study:

9.9.1. A detailed study of your map is essential after planning the route. You must prepare so as to minimize your heads-down time during the low-level. Noting the general shape of the land and its most significant features is a good starting point. A JOG (1:250,000 scale) may initially help you interpret data on the TPC (1:500,000 scale).

9.9.2. Try to visualize the key points along the route and general features around them. Funneling features, such as converging ridgelines, rivers, and roads, are especially helpful in locating selected turn points. Use large, prominent features to funnel your eyes to the smaller features leading to your points. (Navigate from large to small.) To make course measurements significantly more obvious on the route, note the distance you expect to be left or right of features, such as towers, bridges, dams, river bends, etc.

9.9.3. For mid-leg reference points, it is also critical to note the expected time along the route that point becomes significant. This chronological understanding of key navigation points will help reinforce clock-to-map-to-ground pilotage and minimize unnecessary deviations from basic DR. It is also a good technique to memorize the sequence of events, features, and actions required during the IP-to-target run. Thorough map study will significantly aid in a smooth, efficient brief of the sortie. Much of your map study will be accomplished by preparing your map and drawing your route. This step becomes especially important if you are planning to fly a low-level with a map you did not prepare.

Section 9C—Briefing.

9.10. Overview. The overall effectiveness of the sortie can be dramatically affected by how thoroughly and completely the sortie is briefed. Reference the Avian Hazard Advisory System (AHAS) Web site (**http://www.usahas.com/**) prior to the brief and address any significant bird threats.

9.11. Route Briefing:

9.11.1. A commonly accepted technique is to structure your brief so the last thing you cover is the low- level routing itself. This will emphasize the important points and keep them fresh in everyone’s mind.

9.11.2. The briefing should include how you plan to identify and enter the route. As you progress down the route, highlight the critical action points—where you expect to see good track or timing correction points, when to climb or laterally avoid unseen towers or airfields, how high to climb and remain in the route structure, where potential aircraft threats or crossing routes are expected, your specific exit procedures, and what altitude, heading, and frequency you can use in IMC.

9.11.3. Emphasizing specific action points along the route will set the groundwork for good DR (clock-to-map-to-ground). A thorough understanding of what to look for (and when) will also help minimize the airborne tendency to spend too much time map-reading or trying to make what you see on the ground fit what you see on the map.

9.12. Emergency or Contingency Briefing. Emergency or contingency options pose their own unique challenges in the low-level environment. Diverting your attention into the cockpit for too long may have catastrophic consequences. In all abnormal situations on the low-level, your first reaction should be climb-to-cope. You can cover emergency or contingency by leg as you brief or you can cover it as a separate topic from the route brief. Remember, not all emergencies can be covered, but the more thoroughly you brief initial actions, how high (top of the block or ERAA), which way (left or right), which recovery field (primary or emergency), who to talk to, what frequency, the more likely you are to successfully recover the aircraft during a contingency situation. Many aircraft systems are available to assist in building SA in an emergency. Consider briefing incorporation of all EGI and HSD capabilities, even if the capabilities will not be used for the training portion of the sortie.

Section 9D—Flying the Route

9.13. Departure and Route Entry:

9.13.1. Before departing for the jet, referencing AHAS one more time may provide real-time radar tracking of bird activity.

9.13.2. During ground operations, if using an activated FPL for the low-level route, you should ensure:

9.13.2.1. Automatic (AUT) waypoint switching is selected on the UFCP NAV submenu display via Window 3L/UL-3. Automatic waypoint switching continues even when EGI is not the PNS.

9.13.2.2. The TOT calculation method is set to either TOT or TTT, as appropriate. This is set in the FPL sub-menu at UR-2. Selecting the incorrect clock could result in confusing or erroneous data presentation throughout the sortie.

9.13.2.3. Each FPL low-level waypoint is set as a flyover (OVR) point. For OVR waypoints, switching occurs when the aircraft passes within 2 NM of the waypoint, and the EGI bearing pointer swings through the 3 or 9 o’clock position relative to the nose of the aircraft. The waypoint types are available on the MFD FPL display page by selecting the desired FPL. If necessary, change the waypoint type via Window 4L/UL-4 on the UFCP FPL submenu display. Designating enroute FPL waypoints as FBY waypoints could make departure and return navigation easier.

9.13.2.4. TOTs are programmed. The FPL waypoints with an associated TOT are designated in the FPL. Waypoint TOTs are visible on the MFD FPL display page by selecting the desired FPL, or may be set on the UFCP FPL key display.

9.13.2.5. The flight plan waypoints are loaded correctly in the MDP. This can prevent loss of situational awareness once airborne due to a system malfunction, error made during mission planning, or mistakes in other avionics setup. The flight plan waypoints can be quickly verified by:

9.13.2.5.1. Displaying the flight plan track lines on the HSD. This may require you to increase the scale on the HSD to see the entire flight plan. Verify the flight plan route (white line) displays correctly within the displayed route corridor, if available.

9.13.2.5.2. Performing a swing check. During mission planning, determine a bearing and range to each point along the route from a predefined position, typically the EOR. Flight planning software usually has a function that can do this automatically. Manual calculation can be done using your low-level map; however, it may not be as accurate. Once in the aircraft, activate the FPL. Then, when near the position from which the bearing and range were calculated, cycle through each route waypoint as your EGI steerpoint to check the EGI bearing and range against what you calculated during mission planning.

9.13.3. Maintain positional awareness enroute to the entry point, using all available visual references and NAVAIDs, to include EGI. If you are unable to make your originally scheduled entry time, coordinate for a new time or fly an alternate mission.

9.13.4. Make an entry call with the appropriate controlling agency or FSS, and perform a FENCE check into the low-level. Once inside the route structure, accelerate to the planned airspeed. Identify the entry or hack point as early as possible, and maneuver the aircraft to overfly the entry point on the correct heading and at the correct airspeed.

9.13.5. Being at the correct airspeed and heading is more important than immediately descending to your planned route altitude. Start your clock as you pass over the hack point. The aircraft clock can be used via the UFCP; however, you should back it up with an additional hack, either on a watch or the EED clock. Positive identification of your hack point is of utmost importance.

9.14. Route Basics.

9.14.1. Priorities. Avoiding the terrain and anything attached to it is the most critical task during low- level flying. Your first priority will never change—***keep your aircraft under positive control and at an appropriate altitude***. Keep your primary attention out of the cockpit, and do not become fixated on the map, HUD, MFD presentation, or anything else inside the cockpit. Ensure the HUD brightness is at a low enough setting that it doesn't prevent you from effectively clearing for hazards along your flightpath (e.g., birds, other aircraft, changing terrain, and towers). Comply with command-prescribed minimum altitudes, but do not exceed any crewmember's comfort level in an attempt to fly at that altitude. An unfamiliar route, poor visibility, mountainous terrain, or other factors may require a higher altitude to maintain a reasonable level of comfort.

9.14.2. Map-Reading and Pilotage:

9.14.2.1. Map-reading is the determination of aircraft position by matching symbols on a map with corresponding terrain features or manmade objects on the ground. Aircraft position should be determined and navigational errors detected or corrected by using a clock-to-map-to-ground cross- check. Thorough route preparation, study, and briefing will have already determined the best "clock" points to make track or time verifications and adjustments. While flying the route, you must first stay aware of the time elapsed, remembering to consider any timing error from the last leg and how it might affect your current position. Then reference the map for where that should put you (interpolating between tic marks, as necessary) and match the map with what you see outside.

9.14.2.2. When using the full system capabilities of the T-38C, including EGI and HSD, pilots must be extremely vigilant not to become complacent. Avionics systems can provide information to enhance your SA, but failing to integrate the information available with basic low-level flying skills can be catastrophic.

9.14.2.3. Basic pilotage requires pilots to maintain SA above and beyond the aircraft systems' capabilities. The aircraft systems can reduce the workload immensely; however, system errors, data input errors, and poor systems knowledge can negate any benefit gained from the added technology. Unchecked erroneous data may lead you out of the route structure or into unforeseen obstacles. Positional awareness is the only way to ensure terrain and obstacle clearance is maintained.

9.14.3. Flying the Plan. Flying well-planned, accurate headings and airspeeds on each leg will get you close to your selected points. Trust your plan and rely on good DR. Arriving over checkpoints at anticipated times confirms the accuracy of DR and indicates reliability of preplanned headings, winds, and GSs. If a prominent landmark is not available as a reference at a turn point, rely on DR and turn-on time. Conditions such as a cloud cover or extensive areas of featureless land or water may make map reading extremely difficult. By learning to apply the basic principles of DR (time, distance, and heading), you will minimize the loss of SA.

9.15. Altitude:

9.15.1. Judging Altitude. Assessing your height above the ground can be done using several techniques. Obviously, the most accurate method is to use the radar altimeter (RALT). You should cross-check the altimeter, against known elevations of towers, lakes, airfields, or peaks, and use those "snapshots" outside to calibrate your eyes and refine your ability to judge height visually. Set the RALT warning to activate at or above 90 percent of your planned low-level altitude (for example, 500 feet AGL = 450 feet RALT setting).

9.15.2. Terrain and the Horizon. Altitude awareness and the ability to maintain a desired altitude are relatively easy over terrain where large ground objects are present. However, most pilots have a tendency to descend lower than desired over flat, even terrain. This is especially true if there are few significant manmade or natural objects to reference for altitude, such as in high desert plateau country. Very flat terrain, snow, or calm water is exceedingly and insidiously dangerous due to the lack of reliable depth perception. Flat, up-sloping terrain is even more dangerous because of the insidious change in elevation as you fly into the gentle upslope. Flying across sloping terrain may provide a false horizon that can slowly draw you off course as you dip a wing to maintain level flight.

9.15.3. Terrain and Ridge Crossings. Flying low-level in an environment with rapidly changing terrain is demanding and requires constant positional awareness and SA. Realize that terrain can easily hide checkpoints or turn points. Fly upwind of ridges when possible and be alert for areas of turbulence on the downwind side of large terrain features. When planning to cross steep peaks or ridges, consider calculating a start-climb point. Begin the climb early enough to arrive at your minimum AGL altitude prior to the terrain feature or obstacle. To maintain your desired terrain clearance when crossing ridges, either bunt or roll, but do not exceed the limits established in AFI 11-2T-38, Volume 3.

9.15.4. Obstacle Avoidance. ***If lead is unable to visually acquire or ensure lateral separation from known vertical obstructions that are a factor to the route of flight, he or she will direct a climb no later than 3 nm prior to the obstacle to ensure vertical separation by 2 NM from the obstacle. If you visually acquire the vertical obstruction, avoid it vertically by 500 feet or laterally by 0.5 NM.***

9.16. Heading Control. Make every attempt to cross your chosen route start point—usually the hack point—on the precomputed, wind-corrected heading. While on the route, "fly the plan." If using pure DR, consider using the heading set function of the EGI to help maintain the proper heading. When using EGI steering, selecting the flight director or placing the flightpath marker directly over the steerpoint symbol in the HUD will provide wind-corrected heading information. When it is clear that a heading correction is required, consider the following techniques:

9.16.1. Drift Analysis in Flight. In flight, use pilotage to compare your plan against what is actually happening. If the forecast winds were accurate, little or no change should be required to maintain the proper ground track. However, if the winds are inaccurate, adjustments will be required. Look for cues (for example, blowing smoke or an unexpected crab to maintain a known ground track) to verify actual wind direction and adjust accordingly.

9.16.2. Heading Errors. Heading errors can be caused by extracting the wrong heading from the map during preflight planning, applying the magnetic variation incorrectly, or not maintaining the appropriate preplanned magnetic heading in flight. Flying your planned heading is essential. At 360 GS, a 10-degree heading error will take you 2 miles off your course in just 2 minutes.

9.16.3. Visual Track Correction. The simplest and most reassuring way to make a low-level track correction is to positively identify a ground reference and visually reposition your aircraft in proper relation to it. As soon as you determine you are off course, immediately attempt to position yourself back on or near track and assume the correct heading again. Be aware that this technique can add to your leg time. With EGI steering available, you can generally point at the next turn point and concern yourself primarily with timing corrections.

9.16.4. Heading Correction. If you have passed the reference point used to determine your position and you know the distance displaced from the correct ground track, you can correct your error by using the 60-to-1 rule to correct ground track. At 360 knots GS, a 10-degree heading correction held for 1 minute will correct you back toward course 1 mile.

9.16.5. Take Advantage of Unmistakable References. Continue to adjust ground track and airspeed until aircraft position and elapsed time position coincide (especially at predetermined, unmistakable points). When you identify a landmark that shows you are off track, make small corrections immediately to avoid having to make large heading changes later as you get closer to the landmark.

9.17. Timing:

9.17.1. General:

9.17.1.1. The TOT can be based off a TTT hack or a real TOD TOT. If you are using a real-time TOT, back your times up to takeoff so you know the latest possible takeoff time to meet your TOT without modifying preplanned flight parameters. If planning to use aircraft-generated speed cues, ensure the correct format option (TOT or TTT) is set in the FPL sub-menu at UR-2. Allow for the possibilities of being delayed or getting to the start point early. An early arrival may necessitate holding at the entry point, if allowed.

9.17.1.2. When using a TTT running time hack, the system clock provides several unique options. Leg times can be used since the WIT function key on the UFCP will immediately zero out the clock and restart it. This can be accomplished quickly and easily at each turn point or at the IP.

9.17.2. Timing and Airspeed Errors:

9.17.2.1. Low-level route timing is dependent upon flying a precise GS for a precise amount of time. Inaccurately planned airspeed (not corrected for temperature, pressure altitude, or wind) or poor throttle control will almost certainly result in timing errors. Timing errors are further complicated by poor airspeed control when climbing, descending, and turning. For example, if your airspeed and (or) bank angles during turns are not as planned, the turn radius (and thus the timing) will be different. Additionally, timing errors are further complicated by incorrect map-reading and (or) the use of poorly defined landmarks for timing references.

9.17.2.2. If EGI steering is available and a TOT is set, the commanded airspeed will correct for timing errors. There are, however, no limits to the commanded airspeed, and the system could potentially place the aircraft outside the flight envelope and direct you to exceed airspeed training rules. As you get close to the target, the TOT calculations may become less reliable. Disregard large commanded airspeed changes as you approach the steerpoint with the TOT and be careful not to exceed command-directed minimum or maximum airspeeds.

9.17.3. Timing Corrections. There are two basic methods of correcting elapsed time errors on a low- level mission—changing the airspeed and changing the route of flight. The following subparagraphs indicate several methods of airspeed correction:

9.17.3.1. Airspeed Correction—10-Percent Method. This method is based on the approximation that a 10 percent increase or decrease of GS, held for 10 minutes, will gain or lose 1 minute. However, it is not necessary to wait until a 1-minute error exists because the time error (in fractions of a minute) is directly proportional to the duration of the speed change. The calculations for the 10-percent method are as follows:

9.17.3.1.1. 10 percent of GS = GS factor. GS ±

9.17.3.1.2. GS factor = corrected GS.

9.17.3.1.3. Maintain corrected GS for [number of seconds early or late x 10] seconds.

9.17.3.2. Airspeed Correction—Incremental Method. In the incremental method of time control, airspeed in miles per minute is used to determine the speed change. To obtain NM per minute, divide your planned GS by a factor of 60. At 360 knots GS, you are traveling at 6 NM per minute; at 420 KCAS, you are traveling at 7 NM per minute. To determine the speed change increment, multiply the nm per minute by a factor of 10 (for example: 6 NM per minute x 10 = 60 knots). Maintain corrected GS (GS ± the speed change increment) for 1 minute for every 10 seconds early or late.

9.17.3.3. Airspeed Correction—Proportional Method. This method is simple and closely resembles the incremental method. For each second early or late, increase or decrease airspeed by 1 knot for the number of minutes equal to the GS in NM per minute. For example, if you are on a 360 knots GS route (6 NM per minute) and 10 seconds early, decrease airspeed by 10 knots and hold that correction for 6 minutes.

9.17.3.4. Airspeed Correction—Next-Leg Method. This method of timing correction is simple and particularly useful to single-seat pilots. Airspeed (in nm per minute) is used to determine the speed change increment (in GS). First, determine the number of seconds early or late. Divide this by the time (in minutes) for the next leg of the low-level route. Multiply the dividend by the nm per minute. The result is the GS correction. Add or subtract the GS correction to the original cruise airspeed. Fly the corrected GS for the entire next leg. For example, if you are on a 360 knot GS route and 20 seconds late at the IP, the IP to target is 2 minutes and 40 seconds. Increase airspeed by 45 knots and hold the correction for the entire IP-to-target leg.

9.17.3.5. Airspeed Correction—Leg Correction Method:

9.17.3.5.1. Derived from the proportional and next-leg methods, the leg correction method uses a time or distance increment and the next-leg time or distance (either one works) to establish a correction factor for each leg. The time/distance increment is that time or distance at which the proportional method would result in a one-to-one relationship between speed change and seconds early or late. (For example, at 360 knots planned GS, the time or distance increment is 6 min/36 NM. This is because using the proportional method when you are 10 seconds early or late would result in a 10-knot correction held for 6 min/36 NM. At 420 knots planned GS, the time/distance increment is 7 min/49 NM).

9.17.3.5.2. When planning to use this technique, it is best to calculate the correction factor during the planning stage and annotate it on the low-level map. To calculate the correction factor, take the time/distance increment and divide it by the next-leg time/distance. For example, dividing the time/distance increment (6 min/36 NM) by the next-leg time/distance (4 min/24 NM), 6 min/4 min or 36 NM/24 NM yields a leg correction factor of 1.5. Write that correction factor on the low-level map next to that leg. When airborne, determine your timing deviation in seconds and multiply it times your leg correction factor. Apply that correction for the entire next leg. For example, 10 seconds late times the correction factor of 1.5 yields a correction of 15 knots, so fly 15 knots faster for the entire leg. Another technique, increase/decrease ground airspeed 30 knots per one minute for every 5 seconds in timing correction.

9.17.3.6. Airspeed Correction—Ground Track Method. This method is viable only when prominent ground features are used as turn points. If you are within 10 seconds early or late, plan to make the next turn point prior to or just after the desired turn point. Remember to add an additional ground track correction to return to the planned routing and consider the time required for route correction. This technique is heavily based on TLAR (That Looks About Right), but can be used effectively to adjust timing and minimize task saturation. Another technique, a 20 degree check for 30 seconds for every mile off course.

9.18. Turn Point Techniques:

9.18.1. Approaching the Turn Point. Accomplish administrative tasks early to avoid multiple cockpit tasks when performing high bank turns at low altitude. Determine the direction of turn and the desired new heading. Many pilots like to put the heading marker on the next heading. If you approach the turn point from a different ground track than the one on the map, realize that your preplanned turn to the next leg must be altered to put you back on track. Check outside references to visualize the approximate amount of turn required.

9.18.2. At the Turn Point. Cross-check time at (or abeam, if not directly overflying) the turn point to confirm overall elapsed time or the real-world time. Make necessary adjustments after rolling out of the turn. If rehacking at each turn point for DR, rehack just prior to starting the turn.

9.18.3. Making the Turn:

9.18.3.1. Low altitude turns make up 5 percent of low-level flying but account for 52 percent of all low- level accidents. Turn to the next leg when directly over the turn point, using the bank angle and G loading your planned ground track and timing are based on. If you do not visually acquire the turn point, turn on time. **Note:** Use caution when making turns at low altitude because sink rates can quickly develop if you overbank, and there will be little time or altitude with which to recover.

9.18.3.2. In the turn, 100 percent of your attention should be focused on making the turn until you have rolled out, wings level. Make the turn, maximizing outside references. Place the HUD FPM on the horizon, roll and pull to maintain a level turn. In rising terrain, a level turn using the FPM or CDM may not provide sufficient ground clearance. If you detect a descent, immediately rollout of the turn and climb back to a minimum of the altitude you had at the beginning of the turn. If you detect a climb, control the bank to arrest the climb, but do not attempt to descend back to 500 feet during the turn. If you have misjudged the turn, make corrections after rolling wings level and referencing the HSI and HSD.

9.18.3.3. It is critical that you clear throughout the maneuver. Clearing for where the aircraft is going will require you to cross-check the FPM, not focus on it. While in a turn, clear from the top of the canopy to the pitot tube, until you approach the outside reference point for rolling out on course.

9.18.4. Bank Angle and G loading. Table 9.1 shows the Gs required to maintain coordinated level flight at higher bank angles and your time to impact from 500 feet AGL at various overbank or G conditions at any airspeed.

Table 9.1. Time to Impact (Overbank—From 500 Feet AGL).

ITEM	A	B	C	D
	Bank Angle	**Gs for level turn**	**Overbank/Expected G**	**Time to impact**
1	60 degrees	2 G	70 degrees/2 G	9.9 seconds
2	70 degrees	approximately 3 G	80 degrees/3 G	8.1 seconds
3	75 degrees	approximately 4 G	85 degrees/4 G	6.9 seconds

4	80 degrees	approximately 6 G	90 degrees/6 G	5.6 seconds

9.18.5. Effect of Undetected Descent—Time to Impact. Table 9.2 shows your time to impact from 500 feet AGL at various dive angles and a speed of 360 KCAS. **Note:** Any bank angles greatly shorten the time to impact.

Table 9.2. Time to Impact (Attitude—From 500 Feet AGL).

ITEM	A Attitude	B Time to Impact
1	- 2 degrees	approximately 25 seconds
2	- 5 degrees	approximately 10 seconds
3	- 10 degrees	approximately 5 seconds

9.18.6. After the Turn. After completing the turn, ensure NAVAIDs are set with the new heading, fuels are checked, and EGI steerpoint has updated to the next segment.

9.19. Approaching the IP or Target Area. Strive to fly over the IP as close as possible to your planned time. Make any small corrections to timing early to prevent large airspeed corrections later. Depart the IP on planned heading and airspeed. Deviate only as necessary to react to threats (birds, aircraft, obstacles, etc.). Everything that takes place in the target area is critical. In fact, you should have most of the IP-to-target run memorized so that you are not heads-down in the cockpit trying to pick up references from the map.

9.20. Hands On Throttle and Stick (HOTAS) and Air-to-Air (A/A)/ Air-to-Ground (A/G) Master Modes. The T-38C provides avionics capabilities that are used in follow-on training and are similar to follow-on weapon systems. Use of these capabilities during UFT missions for pilot familiarization with HUD and MFD symbology, task management training, and as a HOTAS exercise will help build sound habit patterns for follow-on training. In UFT, the purpose of introducing these capabilities is not to understand weapons employment or how to achieve weapons release parameters. The following is a description of how the T-38C can be used in the UFT environment during low-level training once the student pilot understands the basic principles of flying low-level and demonstrates the ability to safely operate the T-38C in the low-level environment.

9.20.1. Pre-Mission Planning. Units will have a standard DTC load that will provide pilots with mission parameters in the mission planning software for the MFD weapon (WPN) display page that will be suitable for familiarizing pilots with A/G MFD and HUD weapons symbology during low-level missions. The following is an example of parameters that will accomplish this objective: RELEASE ALT: 0; RELEASE VELOCITY: 360; DIVE ANGLE: 0; CONFIGURATION: CLEAN; PROG: A; WPN: BDU-33; BREAK-X: **100**; RIPPLE: 0FT. ***Pilots will confirm these settings on the MFD WPN display page during the "DTC Data – LOAD/VERIFY" step of the "BEFORE TAXIING" checklist.***

9.20.2. HOTAS Low-Level Exercises. While flying the low-level, pilots can use the T-38C HOTAS features (e.g., master mode switch [MMS], default display switch [DDS], weapon mode switch) to change HUD and MFD symbology as part of a task management exercise.

9.20.2.1. Route Entry to IP. Fly the low-level route in the NAV master mode.

9.20.2.2. IP-to-Target. In follow-on training, the IP-to-target run will be the point where tasking will shift to air-to-ground (A/G) weapons delivery. At the IP, it is optional to switch to the A/G CCIP master mode using the MMS and overfly the target level straight through to familiarize yourself with the A/G HUD weapons symbology.

9.20.2.3. Target Egress. Return to the NAV master mode for the remainder of the low-level route.

9.21. Route Exit:

9.21.1. Give the return route leg the same emphasis as the entry leg. If your target is not at (or near) your route exit point, you may need to preplan an off-target point to start route egress.

9.21.2. Once you are clear of the MTR, you are no longer in the low-level structure and are, therefore, limited to 300 KCAS below 10,000 feet MSL. Consequently, a route exit almost always calls for an immediate climb, during which you can trade airspeed for altitude. FENCE out of the low-level.

9.21.3. Whether you are returning IFR or VFR, you will need to coordinate arrival with ATC. When exiting a VR, maintain VFR conditions until you have an IFR clearance. Continue on your IFR clearance when exiting an IR.

9.22. Abnormal Procedures:

9.22.1. Single-Ship, Low-Level Problems and Emergencies. Every low-level emergency, including encountering IMC, requires a climb to a safe AGL altitude. Climb-to-cope is a common phrase to describe your initial action when faced with a problem at low altitude. You must put the aircraft into a position where you can safely analyze the situation and coordinate your recovery with outside agencies.

9.22.2. Unable to Make Radio Contact. If you cannot contact a controlling agency while airborne, follow the local lost-communications procedures, specific route lost-communications procedures (listed in *FLIP AP/1B*), or general lost-communications procedures in the *FLIP Flight Information Handbook*. If you have maintained positional awareness and are able, proceed to your home base or the nearest suitable airfield, as appropriate, while handling the problem.

9.22.3. IMC Route Abort:

9.22.3.1. When it becomes obvious you cannot continue the route without going IMC, abort the route. Pilots must exercise extreme caution in marginal weather conditions and avoid the false sense of security the EGI provides. If possible, turn as necessary to remain VFR. If you cannot avoid IMC while flying a low-level route, immediately abort the route and climb on course to the RAA as a minimum. Make an expeditious climb, using MIL power and a maximum of 300 KCAS. High terrain may require the use of afterburner in some instances. In all cases, immediately establish a climb on course***. Do not, under any circumstances, attempt to reenter the low-level route after initiating an abort.*** Route aborts are potentially disorienting and require an immediate transition to instruments and close attention to aircraft control and flight parameters.

9.22.3.2. Once you are level at or above the RAA, squawk “emergency” as appropriate and coordinate for an IFR clearance to your destination airfield. Because the RAA only provides obstacle clearance within 5 NM of the route, the recovery to your destination may require a higher altitude to ensure obstruction clearance.

9.22.4. Lost Procedures. If you miss consecutive checkpoints or turn points, do not recognize any references from your map, or are unable to reorient yourself (using the EGI if needed), abort the route and follow the VFR lost procedures in **Chapter 8**.

Section 9E—Low-Level Formations

9.23. Two-Ship, Low-Level Navigation. A successful two-ship, low-level mission is the culmination of all your navigation and formation training to this point, requiring a combination of solid low-level practices, formation skills, and discipline.

9.24. Preflight Planning. Preflight planning for a two-ship, low-level mission is usually more involved than either a single-ship, low-level mission or a standard two-ship formation mission. The major addition in the planning process is you are effectively drawing two parallel blackline routes one mile apart. This may require altering the choice of turn points to ensure the formation stays in the corridor, avoids obstacles, and can adjust for significant terrain changes. It is possible to use a preexisting low- level planned for a single-ship mission. However, extra time should be spent during the route study and briefing phases to ensure all formation members are aware of where the wingman should fly to comply with the considerations above.

9.25. Types of Low-Level Formations:

9.25.1. Tactical LAB. When flying over relatively level terrain, LAB formation can work well. The same parameters described in **Chapter 6** should be used, but the wingman should stack level to slightly high on lead. Low-level flying introduces some additional visual cues and takes some time to visually calibrate the proper distance. One technique for stack at 1.0 NM spacing is placing lead aircraft approximately one T-38 wingspan above the horizon for level stack and on the horizon for approximately 60-100 ft high stack.

9.25.2. Wedge. When substantial maneuvering is required or while you are over terrain with vertical development, wedge formation may be a better choice than LAB tactical. It gives the wingman the flexibility to alter sides as necessary and may lessen lead's saturation in ensuring the wingman is on the proper side. The parameters described in **Chapter 6** should be used, but the wingman should stack level to slightly high on lead. One technique for stack at 1.0 NM spacing is placing lead aircraft approximately one T-38 wingspan above the horizon for level stack and on the horizon for approximately 60-100 ft high stack.

9.25.3. Fighting Wing. When a clearing formation is needed or aggressive maneuvering is required, fighting wing may be flown. The parameters described in **Chapter 6** should be used, but the wingman should stack level to slightly high on lead.

9.26. Departure. In addition to managing normal formation responsibilities, you must navigate to the start point and accomplish all other low-level entry requirements for the particular MTR. To enhance clearing and increase the formation's maneuverability, spread the wingman to route, fighting wing, or a tactical formation as soon as possible after takeoff. Unless weather or other procedures dictate, maintain a clearing formation to the route entry.

9.27. Route Entry. If not already accomplished, lead will put the wingman in fighting wing, wedge, or another formation suitable for visual lookout and maneuverability prior to route entry.

In a relatively short span of time, lead must call “entering the route,” locate the entry point, maneuver the formation as necessary for course alignment, call the time hack over the radio, and accelerate to the planned airspeed. Prior planning and solid SA are imperative for a smooth entry into the low-level structure.

9.28. Low-Level “Contract” and Priorities as Lead:

9.28.1. Do Not Hit the Ground or Anything Attached to It. As much as possible, lead should position the wingman on the side opposite high terrain features or known obstacles. Climb the formation in sufficient time to avoid all obstacles within 2 NM of your planned ground track unless you are able to visually acquire and ensure lateral separation from obstacles along the flightpath of the entire formation. Call out any obstacles (towers, etc.) that could be a factor to the formation. Direct the wingman to climb if flying lower than he or she should.

9.28.2. Maintain Vigorous Visual Lookout. Find, call out, and avoid any traffic or birds that could be a factor to the formation. Avoid conflicts and potential midair collision situations with the wingman. TCAS may help to focus the visual lookout and provide additional SA on traffic outside the formation.

9.28.3. Communications and Brevity Code. Use standard brevity code in referring to objects or positions on the ground. Unless lead briefs otherwise, formations use the following plan to communicate whether or not obstacles are in sight. The flight member sighting the obstacle transmits his or her call sign and the clock position of the obstacle relative to their own nose position (for example, "Mach 2, tower, 1 o’clock 4 miles"). The other flight member acknowledges (for example, "Mach 1, contact" or "Mach 1, negative contact"). For traffic acquired on the TCAS but not visually, transmit the position on the TCAS display (for example, "Mach 2, TCAS hit, left 11 o’clock, 5 miles, 300 feet above, descending") The other flight member acknowledges (for example, "Mach 1, same” or "Mach 1, no joy").

9.28.4. Navigate and Lead. Use single-ship, low-level route and timing corrections to fly the route, identify all turn points, and be in a position to arrive at the target on time. In addition to single-ship techniques, you will probably need to incorporate formation check turns, tactical turns, and shackles. Climb the formation for all avoidance areas either you or your wingman will penetrate. Accomplish all turns as briefed, and, unless called otherwise, rollout of each turn on the heading for the next leg.

9.28.5. Maintain SA on the Wingman. Stay visual, direct formation adjustments as necessary, and stay aware of the wingman’s fuel state. Initiate ops checks at appropriate intervals (every 10 minutes or every other leg, as a minimum).

9.29. Low-Level “Contract” and Priorities for the Wingman:

9.29.1. Do Not Hit the Ground or Anything Attached to It. Climb in sufficient time to avoid all obstacles within 2 NM of your ground track unless you are able to visually acquire and ensure lateral separation from them. Call out any obstacles (towers, etc.) that could be a factor to the formation.

9.29.2. Maintain Vigorous Visual Lookout. Find, call out, and avoid any traffic or birds that could be a factor to the formation. Avoid conflicts and potential midair collision situations with lead and of course, stay visual—don’t go blind!

9.29.3. Fly the Prebriefed or Directed Formation Position. Always strive for the briefed formation position unless turn requirements or safety dictate otherwise. In tactical LAB or wedge formations, stack level to slightly high. At 500 feet AGL, lead will be on the horizon to very slightly above the horizon when you are stacked level at 6,000 feet laterally. Whenever a flightpath conflict with lead exists, cross high in relation to lead.

9.29.4. Maintain SA on Navigation, Route, and Timing. Strive to maintain sufficient positional awareness so you know when to expect key events such as turns, climbs, and position changes. Unless called otherwise, rollout of each turn on the planned heading for the next leg. Strive to maintain enough SA to confidently assume the lead if necessary.

9.30. Low-Level Turns as Lead:

9.30.1. Wingman on the Inside of the Turn. Begin your contract turn over the planned turn point to keep your aircraft on the planned ground track. Unless briefed otherwise, the wingman should climb to deconflict, if necessary.

9.30.2. Wingman on the Outside of the Turn. From tactical LAB, start the wingman turning early enough to allow you to delay your turn until right over the planned turn point. A turn of 90 degrees will require a lead point of 1 NM, a turn of 45 degrees will require a lead point of ½ to ¾ NM and a turn of more than 90 degrees will require a lead point of more than 1 NM. For a 90- or 45-degree turn, use the same references described in **Chapter 6** for tactical turns. For a turn of greater than 90 degrees, turn sooner than the 90-degree turn reference.

9.30.3. Turns of 30 Degrees or Less. Normally, you can simply turn to the new heading; a delayed turn is not necessary. For a planned check turn into the wingman, brief him or her to drop back closer to the 30-degree line before the turn. Depending on the formation at the time, it will always be your option to direct an unplanned check or tactical turn.

9.30.4. Misjudging a Tactical Turn. If you misjudge the timing of a tactical turn at a turn point, the corrective action depends on several factors (threat, positional awareness, width of corridor, fuel remaining). It may be more important to maintain good formation (threat, fuel, good positional awareness) or, it may be more important to fly the route (poor positional awareness, narrow corridor). If maintaining formation parameters is most important and the lateral limits of the low-level corridor permits, lead may time the turn to complete it with the formation in the desired position, and then re-intercept the planned routing further down the route. If, however, corridor width will not permit, or if this would excessively degrade your navigational SA, lead should turn over the planned point and have the wingman regain formation position as soon as possible.

9.31. Low-Level Turns as the Wingman. Turns during low-level tactical maneuvering will rarely be exactly 90 or 45 degrees. You must anticipate turns and remain aware of the new heading at each turn point. Once lead is established on the next leg of the route, expeditiously correct back to the briefed or directed formation position if out of position.

9.31.1. Wingman on the Inside of the Turn. Delay your turn until lead has turned an appropriate number of degrees to allow you to complete the turn in the proper tactical position. For a turn of 90 or 45 degrees, use the same references as a turn in the MOA. For a turn of greater than 90 degrees, turn sooner than the 90-degree turn reference. If you misjudge your turn, vary your power and (or) G loading to compensate and regain proper tactical position. Unless briefed otherwise, climb to deconflict if necessary.

9.31.2. Wingman on the Outside of the Turn. Anticipate the turn and the call or signal from lead. Have the rollout heading in mind, execute a contract turn, and climb to deconflict if necessary.

9.32. Low-Level Position Changes. Accomplish position change by following the guidance in **Chapter 6**.

9.33. IP-to-Target Run. Lead will designate what specific target point each formation member will overfly in the target area and the formation position to fly. Lead should brief the wingman when and how to begin maneuvers to attain the planned formation position for target overflight. This maneuver can occur at a given distance from the target, over a specific ground reference, or upon lead's direction. If both aircraft overfly the same target point, ground tracks will be designed to ensure timing deconfliction. Maneuvers can include a check away from lead followed by a turn toward the target at a given range, or the wingman can deploy to wedge prior to turning in toward the target. The wingman must remain visual with lead at all times. ***All formation members will overfly their designated target point level-straight-through.***

9.34. Target Egress. The flight lead should plan and brief a method for achieving a designated tactical formation (preferably LAB) off the target. An example would be a preplanned turn by the wingman to the egress heading, and a lead ground track to that heading that brings the wingman forward to LAB.

9.35. Lost-Sight Situations:

9.35.1. When Wingman Loses Sight. During low-level tactical turns, you may momentarily lose sight of lead. This is acceptable as long as you regain sight of lead at an appropriate time. However, if you do not regain sight at an appropriate time or if you unexpectedly lose sight at any other time, transmit your callsign along with "blind." Maintain your current heading and climb to 1,000 feet AGL or as briefed to help ensure deconfliction and terrain clearance while you search for lead. If you regain sight of lead, call "visual" and continue the mission. However, if you are unable to regain sight of lead after the climb, continue to ensure terrain clearance and follow lead's instructions.

9.35.2. Lead Actions When Wingman Loses Sight:

9.35.2.1. If the wingman calls "blind" and you have the wingman in sight, start a climb to 1,000 feet AGL, and transmit your callsign, the word "visual," and your relative position. If the wingman visually acquires you in the climb, you may descend back to 500 feet AGL.

9.35.2.2. If the wingman is still unable to visually acquire you, direct him or her to maintain or pick up an appropriate altitude and heading. Consider a moderate, controlled wing rock, but guard against excessive maneuvering that could lead to disorientation. If necessary, rejoin on the wingman while talking their eyes onto you. Once the wingman has you visually, direct him or her to an appropriate formation position and continue the route if conditions and corridor boundaries allow.

9.35.3. A "Double-Blind" Situation—Wingman and Lead Both Lose Sight:

9.35.3.1. If the wingman calls "blind" and you, as lead, do not have him or her in sight, maintain your current heading, and direct the wingman to maintain the same heading. Begin a climb to 1,000 feet AGL, and direct the wingman to climb to 1,500 feet AGL.

9.35.3.2. If both aircraft regain sight of each other in the climb, lead may descend back to 500 feet AGL and continue the mission. If lead visually acquires the wingman in the climb, both will follow the procedures in **paragraph 9.35.2.1**. If neither aircraft regains sight, both will continue to the next turn point, using landmarks along the route to try to find each other. When arriving at the next turn point, if still not visually acquired, lead will be directive. ***Do not continue the route as a formation.***

9.35.3.3. You must be aware of fuel remaining, aircraft scheduled after you on the low-level, and how much time can be spent attempting to get back together. Relay your position to the wingman, using a timing reference or landmark along the route.

9.35.3.4. Normally, lead and the wingman will both abort the low-level route. Once they climb out of route, they do not reenter the MTR. If still unable to regain sight of each other with altitude deconfliction during the abort, accomplish single-ship recoveries. During single-ship recoveries, ensure altitude separation from the wingman until confirming radar contact with a controlling agency.

9.35.3.5. Techniques to help regain sight include: using TCAS, comparing distance to next EGI turn point, differential airspeeds to create closure, ground references, position off bullseye, using air-to-air TACAN, holding at the next time point, etc.

9.36. Radio Failure:

9.36.1. Lead Loses Radio. Accomplish all radio failure cockpit and equipment checks. If radio failure is confirmed or strongly suspected, climb to a minimum of 1,000 feet AGL and rejoin the wingman. Once rejoined, give the appropriate AFI 11-205 visual signals, and follow the briefed no radio (NORDO) procedures.

9.36.2. Wingman Loses Radio. Accomplish all radio failure cockpit and equipment checks. If radio failure is confirmed or strongly suspected, climb to a minimum of 1,000 feet AGL and rock your wings to get lead's attention. However, do not sacrifice aircraft control in an attempt to gain lead's attention and do not close to within 500 feet of lead until given the proper signal. If, as lead, you notice the wingman flying at 1,000 feet AGL or higher and rocking his or her wings, climb to at least 1,000 feet AGL and have the wingman rejoin. Once rejoined, give the appropriate AFI 11-205 visual signals for the situation.

9.37. IMC Route Abort:

9.37.1. Lead Actions:

9.37.1.1. When possible, avoid IMC by climbing or turning. Use an in-place turn if necessary. If IMC penetration is imminent, attempt to rejoin the wingman while maintaining VMC. If unable to maintain VMC until the wingman is rejoined, ensure the flight initiates a wings-level climb to RAA minimum with the required altitude separation. This will allow the wingman to stay above you. RAA deconfliction should be briefed.

9.37.1.2. Ensure the wingman is paralleling your heading and squawk "emergency" on the IFF/SIF as soon as practical. To lessen the chances of a midair collision with the wingman, do not turn while in IMC.

9.37.1.3. If unable to reach VMC above the RAA, ensure altitude separation with the wingman and attempt to contact a radar facility. If you are unable to contact a radar facility, climb to a higher altitude while still ensuring altitude separation with the wingman. Continue to climb, and squawk “emergency” until reaching VMC or contacting a radar facility.

9.37.2. Wingman Actions. When directed, rejoin as expeditiously as possible without becoming a hazard to the formation. If you are unable to rejoin prior to entering IMC, make a slight turn away from lead until ensuring altitude separation. Then parallel lead's heading and follow lead's instructions. Wingman should squawk as briefed as soon as task management allows so TCAS can confirm separation.

Chapter 10

NIGHT FLYING

10.1. Ground Operations:

10.1.1. Mission Briefing. In addition to the normal briefing items, night flying requires discussing, in detail, the lighting (cockpit, aircraft, airfield, and environment), taxi spacing and distance, radio procedures, alternate or emergency airfields, and a host of other items that, during day operations, are simply considered standard. Accomplishing something as simple as filling out a lineup card in black ink will ease your task requirements for night flight.

10.1.2. Preflight Power. ***If external power is available, pilots will use it to thoroughly check all aircraft lighting (interior and exterior) including the map light. Ensure the marshaller has two illuminated wands.***

10.1.3. Interior Inspection and After Start:

10.1.3.1. During the interior inspection:

10.1.3.1.1. Dim the marker beacon, and AOA indexer lights.

10.1.3.1.2. Rotate the three lighting rheostats on the right console (instrument, flood, and console lights) out of the OFF position.

10.1.3.1.3. Set the EED OFF/NIGHT/DAY (OND) power knob to night, and adjust the EED brightness via the brightness (B) rocker switch.

10.1.3.1.4. Position the instrument panel map lights and the utility light as desired. Consider selecting the red lens on the utility light and your flashlight.

10.1.3.2. With external power:

10.1.3.2.1. Adjust the lighting on the instrument, flood, and console lights to the lowest practical setting.

10.1.3.2.2. Dim the warning, caution, and advisory lights to avoid excessive cockpit reflection or glare.

10.1.3.2.3. On the UFCP, place the NT/AUT/DAY toggle switch to NT for the HUD night brightness range.

10.1.3.2.4. Adjust the display brightness of the UFCP using the UFCP U BRT rocker switch on the UFCP. **Note:** UFCP key illumination is controlled by the instrument light rheostat.

10.1.3.2.5. Adjust the display brightness of the HUD using the HUD H BRT rocker switch on the UFCP.

10.1.3.2.6. Set the MFD OND power knob to night, and adjust the MFD display brightness via the BRT rocker switch.

10.1.3.3. Without external power, check all interior lights mentioned in **paragraphs 10.3.1.2.1** through **10.3.1.2.5** after starting engines.

10.1.4. Before Taxi. If adequate airfield lighting exists, delay turning on the landing light until you are out of the chocks to avoid blinding the crew chiefs. Because the rotating beacon may hinder maintenance personnel while they are under the aircraft, consider turning it off.

10.1.5. Taxi***. Taxi on centerline with a minimum of 300 feet spacing from preceding aircraft.*** Taxi speeds should be slower because speed and distance estimation are difficult during night operations. Solo students should accomplish all checklist items while stopped.

10.2. Single-Ship Takeoff. Line up on the runway centerline, and recheck the EADI and EHSI. After run-up checks and brake release, use the composite method of aircraft control you learned during day transition flying. Remain oriented to the instrument references as well as outside objects to minimize the chance of spatial disorientation. Certain weather conditions or a lack of visual cues may necessitate a complete transition to flight instruments immediately after takeoff. The rate of transition to instruments should correspond with the rate at which outside references fade. Ensure the aircraft is safely airborne before raising the landing gear handle, and be aware that the retracting landing light can give a false sensation of increasing pitch.

10.3. Use of Night Visual References:

10.3.1. Visual references and depth perception change with night operations. To overcome the decrease in visual cues, use instruments to a greater extent. Throughout the sortie, continue to adjust cockpit lighting to maximize your night vision, decrease glare, and minimize reflections.

10.3.2. At night, lighted objects often appear closer than they actually are. Because altitude and rate of descent are more difficult to judge close to the ground, rely more on the altimeter and IVV than on visual perception. Cross-check the EADI to determine the proper aircraft attitude when no definite horizon exists.

10.3.3. Although there is an increased emphasis on flight instruments at night, visual references are still the primary means of orientation during night VMC operations. However, if you detect an unusual attitude or feel the effects of spatial disorientation, immediately make a transition to flight instruments and recover.

10.4. Depth Perception. Use caution when descending for the initial traffic entry at night because height above the ground is difficult to judge. Check the altimeter closely during night operations to ensure a proper interpretation.

10.5. Night Optical Illusions. Use caution when flying approaches, especially to a strange field. Sloping or featureless terrain, sloping runways, varying runway widths, runway lighting intensity, and (or) weather phenomena can cause visual illusions at night. One of the best defenses against illusions at a strange field is thorough preparation. Study the airfield and approach diagrams, and become thoroughly familiar with its lighting and glidepath guidance systems.

10.6. Visual and Instrument Straight-In Approaches. Whether practicing visual or instrument straight-in approaches at night, approach control normally provides positive radar control for pattern spacing and sequencing to final. Do not rely entirely on visual cues. Use composite flight references, to include glidepath, course, and lighting system guidance.

10.7. Overhead Patterns:

10.7.1. Clearing. The night pattern can get very busy so it is critical to clear visually, on the radios, and on TCAS. It is difficult to tell whether an aircraft is turning crosswind or pulling closed. Listening carefully to the radio call will help you know aircraft position and intention. If in doubt, turn crosswind, carry straight through initial, or break out, as applicable.

10.7.2. Pattern Entry and Break. Clear and complete the entry and turn onto initial or radar initial the same as during daylight operations. Because you may not see the runway clearly, initiate the break by referring to the ramp or other lighted areas on the field. Initiating the break with traffic abeam you on closed downwind will ensure 6,000 feet of runway separation. Continue to use a composite cross-check during the break to maintain aircraft control.

10.7.3. Final Turn and Final. Fly the turn to final and final approach using a composite cross-check, because some visual cues will be hard to see (for example, a horizon). A good technique is to emphasize being on airspeed at desired altitudes for the perch, halfway through the final turn, and especially rolling out on final.

10.7.4. Transition to Landing and Landing. The references for night landings are the same as daytime references. The main difference between night landings and day landings is the lack of peripheral cues to help judge glideslope angle and height above the runway. Long, fast landings at night are especially dangerous as many of the daytime runway's cues may not be available. As you approach the overrun, the landing light will illuminate the surface of the overrun and runway, helping with depth perception. Do not use the runway lights as the only reference to judge height above the runway because they can lead to a high flare and a dropped-in landing. ***Plan to land on the runway centerline.***

10.8. Night Formation:

10.8.1. Mission Briefing. In addition to normal briefing items, emphasize visual signals, radio procedures, crew coordination, spatial disorientation, and lost wingman procedures.

10.8.2. Takeoff:

10.8.2.1. Lead. In addition to winds, etc., consider the location of ramp lights when positioning a wingman for a night takeoff. As you take the runway, dim the position lights and turn off the rotating beacon. Normally, unless specified in unit standards, replace the daylight visual signals with radio calls for engine run-up, brake release, and gear retraction. When lighting conditions permit, you may brief visual signals.

10.8.2.2. Wingman. Position lights should remain bright and rotating beacon on.

10.8.3. In Flight:

10.8.3.1. Lead. Based on weather, natural lighting, visible horizon, and available ground references, use the same wingman considerations during night formation maneuvering as during day IMC maneuvering. Depending on proficiency, slower roll rates may be preferred.

10.8.3.2. Wingman. To maintain the normal fingertip position at night, cross-check references more often than during the day. Do not stare at any one light on lead's aircraft because this may result in a loss of depth perception. When you are in fingertip position, your rotating beacon will reflect off lead's aircraft and help your depth perception. If you fall low, you will lose that effect.

10.8.3.3. Route. Because of reduced visual cues, flying route at two- to three-ship widths and forward of the wing line will maximize the illumination effect of the rotating beacon. During turns into the wingman, number 2's beacon will illuminate lead. During turns away, this effect is lost. Under certain conditions (little moon illumination, poor horizon, haze), consider reforming number 2 into fingertip before a turn away.

10.8.3.4. Crossunder. Crossunders may be initiated with a visual signal or radio call. Make all control inputs smooth and deliberate. Crossunders should take a little longer at night due to reduced visual cues.

10.8.3.5. Formation Approach. Normally, lead will call gear extension and retraction over the radio. If the wingman's landing light becomes a distraction, lead should direct him or her to turn it off. A radio call or zipper may be used to initiate a go-around from the low approach.

10.8.3.6. Position Change. ***Night position changes will be made over the radio.*** The aircraft assuming the lead should dim the position lights and turn off the beacon. The aircraft assuming the number 2 position should do the opposite.

10.8.3.7. Night Overhead Traffic Pattern Split-up. As soon as practical after the split-up, lead will turn on the rotating beacon and return the position lights to the bright setting. Normally, the wingman should delay the break for about 8 seconds to build 6,000 feet of spacing behind lead.

TOD D. WOLTERS, Lt Gen, USAF
DCS, Operations, Plans and Requirements

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

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AFPD 11-2, *Aircrew Operations*, 19 January 2012

AFI 11-2T-38, Volume 3, *T-38 Operations Procedures*, 2 October 2015

AFI 11-202, Volume 3, *General Flight Rules*, 10 August 2016

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AFMAN 33-363, *Management of Records*, 1 March 2008

TO 1T-38C-1, *Flight Manual, USAF Series T-38C Aircraft*, 16 March 2016

Adopted Forms

DD Form 175, *Military Flight Plan*

AF Forms 847, *Recommendation for Change of Publication*

AF IMT 70, *Pilot's Flight Plan and Flight Log*

AFTO Form 781, *ARMS Aircrew/Mission Flight Data Document*

Abbreviations and Acronyms

A/A—air-to-air

AA—aspect angle

A/G—air-to-ground

Admin—administrative

AGL—above ground level

AGSM—anti-G straining maneuver

AHAS—avian hazard advisory system

AOA—angle of attack

ARTCC—air route traffic control center

ATC—air traffic control

ATIS—automated terminal information service

AWOS—Automated Weather Observation System

BD—battle damage

BFM—basic fighter maneuvers

CAS—calibrated airspeed

CDI—course deviation indicator

CDM—climb dive marker

CHUM—chart update manual

CRN—chronometer

CSW—course select window

DEST—destination

DH—decision height

DLO—desired learning objectives

DME—distance measuring equipment

DR—dead reckoning

DTC—data transfer cartridge

EADI—electronic attitude director indicator

EED—electronic engine display

EGI—embedded global positioning and inertial navigation system

EGT—exhaust gas temperature

EHSI—electronic horizontal situation indicator

ENDR—endurance

ENJJPT—Euro-NATO Joint Jet Pilot Training

EOR—end of runway

ET—extended trail

FAA—Federal Aviation Administration

FAF—final approach fix

FBO—fixed base operator

FBY—flyby

FCP—front cockpit

FD—flight director

FENCE—fire control, emitters, NAVAIDs, communications, and electronic countermeasures (as in FENCE check)

FL—flight level

FLIP—Flight Information Publications

FM—fluid maneuvering

FOD—foreign object damage

FOV—field of view

FPL—flight plan

FPM—feet per minute

FPM—flightpath marker

FSS—flight service station

GPS—global positioning system

GS—groundspeed

HAT—height above touchdown

HCA—heading crossing angle

HOTAS—hands on throttle and stick

HSD—horizontal situation display

HSI—horizontal situation indicator

HUD—heads up display

IAF—initial approach fix

IAW—in accordance with

ICAO—International Civil Aviation Organization

IFF/SIF—identification, friend or foe/selective identification feature

IFR—instrument flight rules

ILS—instrument landing system

IMC—instrument meteorological conditions

IMN—indicated Mach number

INS—inertial navigation system

IP—instructor pilot, initial point

IR—instrument route

ITO—instrument takeoff

IVV—instantaneous vertical velocity

JOG—joint operational graphic

KCAS—knots calibrated airspeed

KIO—knock-it-off

LAB—line abreast

LOS—line of sight

MAJCOM—major command

MAX—maximum afterburner/maximum power

MDA—minimum descent altitude

MDP—mission display processor

MFD—multi-function display

MIL—military (power)

MIL-STD—military standard

MMS—master mode switch

MOA—military operations area

MSL—mean sea level

MTR—military training route

NAV—navigation

NAVAID—navigational aid

NM—nautical mile

NOTAM—notice to airman

ONC—operational navigation chart

OND—OFF/NIGHT/DAY

OVR—flyover

PAPI—precision approach path indicator

PAR—precision approach radar

PIO—pilot induced oscillation

PIREP—pilot report

PIT—Pilot Instructor Training

PMSV—pilot to metro service

PNS—primary navigation source

POM—plane of motion

PP—present position

PPH—pounds per hour

RAA—route abort altitude

RAIM—receiver autonomous integrity monitoring

RALT—radar altimeter

RNAV—area navigation

ROE—rules of engagement

RPM—revolutions per minute

RSU—runway supervisory unit

RTB—return to base

RVSM—reduced visual separation measure

SA—situational awareness

SOF—supervisor of flying

SR—slow route

STAR—standard terminal arrival route

SUPT—Specialized Undergraduate Pilot Training

TA—transition altitude

TACAN—tactical air navigation

TCAS—traffic collision avoidance system

TOD—time of day

TOLD—takeoff and landing data

TOT—time over target

TPC—tactical pilotage chart

TR—training rule

UFCP—up front control panel

UHF—ultra high frequency

UFT—undergraduate flying training

VASI—visual approach slope indicator

VDP—visual descent point

VDTS—**-**video data transfer system

VFR—visual flight rules

VHF—very high frequency

VMC—visual meteorological conditions

VOR—very high frequency omni-directional receiver

VORTAC—very high frequency omni-directional receiver / tactical air navigation

VR—visual route

WIT—witness

WPN—weapon

WSSP—weapon system support pod

Terms

3/9 Line—An imaginary line extending through the 3- and 9-o'clock positions of an aircraft (also known as the pitch or lateral axis).

Abort—Directive to cease the action, attack, event, or mission.

Acceleration maneuver—A maneuver flown to increase airspeed. Zero G is optimum.

Admin lead—Used to pass lead responsibilities to another member of the flight. The administrative (admin) lead is expected to run all aspects of the profile to include navigating, managing the radios, and making changes to the profile if external conditions dictate (for example, changing the bingo fuel with a change in the alternate). With an admin lead change, the callsigns within the flight are administratively renumbered to match the position being flown. Lead still retains ultimate authority for the formation.

Angle—off—The angle formed by the extension of the longitudinal axes of two aircraft; the difference in headings. Also called the heading crossing angle (HCA).

Aspect angle—The angle measured from the tail or longitudinal axis of one aircraft to another aircraft's position. For example, 0 degrees aspect angle is directly behind and 180 degrees aspect angle is directly in front. The aspect angle is independent of the other aircraft's heading.

Bingo—A prebriefed fuel state needed for recovery using prebriefed parameters.

Blind—No visual contact with friendly aircraft; the opposite of "visual."

Break (Up, Down, Right, or Left)—To perform an immediate maximum performance turn in the indicated direction. Assumes a defensive situation.

Cleared—Requested action is authorized.

Closure—Overtake created by airspeed advantage and (or) angles. The rate at which range decreases (also known as VC: closure velocity "V-sub-C"). Closure can be positive (getting closer) or negative (getting farther away).

Cross turn—A 180-degree heading reversal by a flight where aircraft turn into each other.

Divert—Proceed to alternate mission or base.

Element lead—The pilot responsible for the conduct of a two-ship element. In a two-ship formation, the element lead is the flight lead (see definition). Number 3 is the element lead in a four-ship formation. (Normally, one wingman should not fly formation off of another wingman.)

Extension or acceleration maneuver—An unloaded maneuver, almost always at a high-power setting, to gain airspeed and either generate closure (decrease distance) or increase opening velocity (separation).

FENCE—The boundary separating hostile and friendly areas. Entering or exiting designated area.

FENCE check—Set cockpit switches as appropriate.

Flight lead—The individual typically in the #1 position in the formation, referred to as lead, and charged with the safe and successful completion of the mission. Wingmen may lead portions of the mission, but the designated flight lead does not change.

High six—A position physically above and behind an aircraft regardless of heading or bank angle.

Joker—Fuel state above bingo at which separation, bug out, or event termination should begin and proceed with the remainder of the mission.

Knock—**it-off—**Training term used to stop maneuvers in progress for safety of flight issues.

Lag pursuit—Maneuvering to control closure, range, and (or) aspect angle by positioning the lift vector (or flightpath) toward the outside of another aircraft's turn circle. Lag pursuit usually decreases aspect angle.

Lag reposition—An out-of-plane maneuver performed to control overtake, decrease aspect angle, and (or) prevent an overshoot by using vertical turning room above and behind another aircraft's plane of motion.

Lead pursuit—Maneuvering to control closure, range, and (or) aspect angle by positioning the lift vector (or flightpath) toward the inside of another aircraft's turn circle. Lead pursuit usually increases or maintains aspect angle.

Lead reposition—An out-of-plane maneuver generally performed to increase overtake and aspect angle and (or) decrease range by using vertical turning room below another aircraft's plane of motion.

Lift vector—An imaginary plane going vertically through the top of the aircraft, representing the plane of motion in a straight pull. "Set the lift vector" means to roll the aircraft to set the point you want to pull to at your 12 o'clock high.

Line abreast—Side by side. Typically a formation position but can be used to describe groups, contacts, formations or aircraft positions relative to each other.

Line of sight (LOS)—A direct line between two aircraft.

LOS rate—Speed of apparent drift of one aircraft in relation to another, speed of angular change of LOS.

Nav lead—May be used when lead wants the wingman to navigate and clear. Lead will fly the wingman position, deconflict within the flight, and keep the radios; for example, battle damage (BD) check.

Ops check—Periodic check of aircraft systems performed by the aircrew (including fuel) for safety of flight.

Overshoot (flightpath)—Results in one aircraft crossing through or behind the flightpath of the other aircraft, but not necessarily in front of the other aircraft's 3/9 line.

Overshoot (3/9 line)—Results in the aft aircraft flushing forward of the other aircraft's 3/9 line.

Perch—A position behind and to the side of an aircraft used to define a starting point for follow-on maneuvering.

Plane of motion—A plane extending from the flightpath of an aircraft to the center of its turn radius.

Pure pursuit—An aircraft with its nose pointing at another aircraft is in “pure pursuit.”

Push—Change frequency without acknowledgment.

Quarter plane—A last-ditch maneuver used to prevent a 3/9 overshoot or to “preserve 3/9 line” at closer ranges and higher LOS rates.

Radial G—The vector sum of the aircraft's lift vector and gravity when turning in a vertical POM; that is, the G effectively turning the aircraft.

Squawk—Operate IFF as indicated or IFF is operating as indicated.

Tactical lead—May be used when lead needs the wingman to lead an event (for example, extended trail) or a segment of the flight. In this case, the wingman will pick up tactical, navigation, and radio responsibilities but not the overall flight lead responsibility. Individual callsigns do not change.

Terminate—Training term used to stop maneuvers in progress for non-safety of flight issues.

Turn circle—The flightpath described by an aircraft in a turn.

Turn radius—The distance between an aircraft’s flightpath and the center of the turn circle.

Turn rate—Degrees per second an aircraft turns.

Turning room—Volume of airspace in the vertical, horizontal, or both, which can be used to execute a desired maneuver.

Visual—Sighting of a friendly aircraft or ground position; the opposite of “blind.”

Zipper—A double-click of the microphone button used to attract the attention of another pilot in the formation without compromising mission information (for example, callsigns or flight composition) or cluttering the frequency.

Attachment 2

STADIAMETRIC RANGING

A2.1. Stadiametric Ranging. Stadiametric ranging ("mil sizing") is a crude method for estimating target ranges. It uses the relationship between angles and the arcs they subtend over a given distance to help determine the distance to a target. A radian is the angular measurement in a circle where the arc length (radian) is equal to the radius length. One milliradian (mil) is an angular measure. Further explanation on calculations follows:

A2.1.1. One radian = 57.3 degrees (approximately)

A2.1.2. One mil = radian ÷ 1,000 = 0.057 degrees

A2.1.3. One degree = 17.45 mils

A2.1.4. One mil = arc length ÷ range

A2.1.5. Range can be any unit: foot, meter, etc.

A2.1.6. Example: 1 mil = 3 feet at 3,000 feet or 3 meters at 3,000 meters

A2.2. Range and Mils :

A2.2.1. Range and mils have the following relationship:

A2.2.1.1. Range = Wingspan / mils X 1,000

A2.2.1.2. Mils = Wingspan / Range X 1,000

A2.2.2. Since the size of the T-38 is known, mil sizing can be used to determine range from the other aircraft or predict aircraft size at a given range. Table A2.1 shows T-38 mil sizes at 0° AA (T-38 wingspan = 25 ft 3 in) and at 90° AA (T-38 length = 46 ft 4 in) using stadiametric ranging**.**

A2.3. General Procedures and Examples . Since ET is flown at low AAs, these examples use wingspan as the known distance in examples for 0° AA.

A2.3.1. To determine range from another aircraft, divide wingspan in feet by apparent size in mils and multiply by 1,000. For example, a T-38 (25 foot wingspan) at 0° AA is 25 mils wingtip to wingtip in your HUD. Your range is 25 feet divided 25 mils multiplied by 1,000 = 1,000 feet.

A2.3.2. To predict size (in mils) of another aircraft at a defined range, divide wingspan in feet by the desired range and multiply by 1,000. For example, at 6,000 feet and 0° AA, a T-38 will be 25 feet divided by 6,000 feet multiplied by 1,000 = 4.1 mils.

Table A2.1. T-38 Mil Sizes at Various Ranges.

I	A	B	C	D	E	F	G	H
T		RANGE (feet)						
E M	AA (degrees)	6,000	5,000	4,000	3,000	2,000	1,000	500
1	0°	4 mils	5 mils	6 mils	8 mils	13 mils	25 mils	50 mils
2	90°	8 mils	9 mils	12 mils	15 mils	23 mils	46 mils	92 mils

A2.3.3. In general, mil sizing could be adjusted when you are not approaching your target on an exact aspect. However, you may consider the 0° AA number suitable for perch entries to ET.

A2.4. HUD Symbol References. Once you know what size, in mils, an aircraft should be at different ranges, you can use symbol references available to you on the HUD to determine your range from the aircraft. Dimensions of the HUD bore sight cross/gun cross are illustrated in Figure A2.1, dimensions for the MIL-STD HUD aircraft waterline are illustrated in **Figure A2.2**, and dimensions for the F-16 HUD FPM are illustrated in **Figure A2.3** The following examples show how mil sizing can be used during UFT formation flying when you are approaching an aircraft at low aspect, for example as wing during a straight-ahead rejoin or during the perch entry to ET:

A2.4.1. At 6,000 feet, Lead is approximately 4 mils which equates to slightly less than the width of a single horizontal line on the gun cross.

A2.4.2. At 5,000 feet, Lead is approximately 5 mils which equates to the width of a single horizontal line on the gun cross.

A2.4.3. At 4,000 feet, Lead is approximately 6 mils, approximately half the width of the entire gun cross.

A2.4.4. At 3,000 feet, Lead is approximately 8 mils, approximately the width of the gun cross minus one of its horizontal lines.

A2.4.5. At 2,000 feet, Lead is approximately 13 mils, the width of the gun cross.

A2.4.6. At 1,000 feet, Lead is approximately 25 mils, approximately twice the width of the gun cross.

A2.4.7. At 500 feet (inside the cone), Lead is approximately 50 mils, approximately 4 times the width of the gun cross.

Figure A2.1. HUD Boresight Cross/Gun Cross Mil Dimensions.

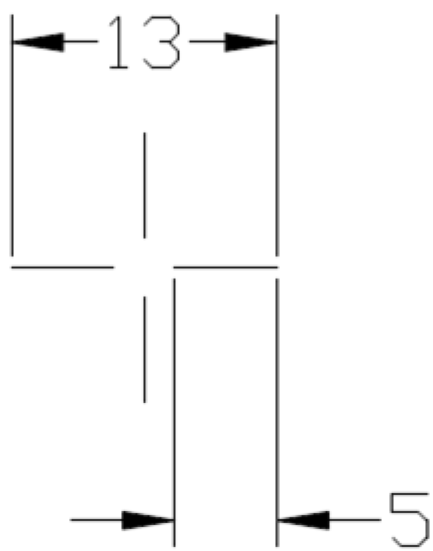


Figure A2.2. MIL-STD HUD Aircraft Waterline Mil Dimensions.

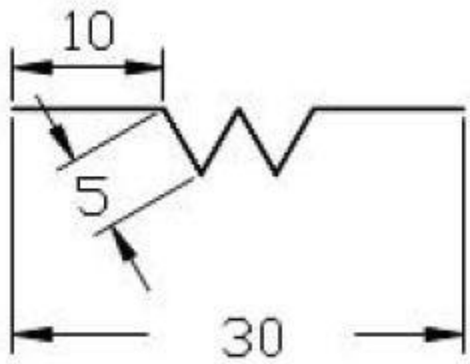
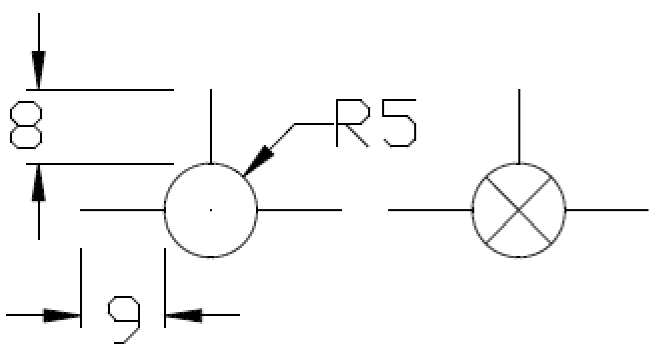


Figure A2.3. F-16 HUD FPM Mil Dimensions.



Attachment 3

GUNS-TRACKING EXERCISE AND HEAT-TO-GUNS EXERCISE

A3.1. Purpose. The purpose for the guns-tracking and heat-to-guns exercises is to build on the fundamentals learned in FM to place the aircraft in a position to employ weapons. The objectives are the same as those for FM (**paragraph 6.44**) but also include:

A3.1.1. Introduce and practice using HUD air-to-air symbology.

A3.1.2. Introduce simulated infrared missile and gun employment from a stabilized WEZ.

A3.2. WEZ. The WEZ is an area in relation to another aircraft from which valid weapons may be employed with the greatest probability of achieving desired results. The WEZ is different for each type of weapon. The exercises in this attachment will simulate the use of the AIM-9P air-to-air missile and the 20 millimeter (MM) cannon.

A3.2.1. The WEZ for the 20MM cannon during the guns-tracking exercise is a range between 2,500 feet and 1,000 feet and an AA <135 degrees. ***Desired aspect angle for gun employment is 20 to 50 degrees. Offenders must cease weapons employment with enough time and range to avoid a 1,000foot training bubble.***

A3.2.2. The WEZ for the AIM-9P during the heat-to-guns exercise is a range between 9,000 and 2,000 feet and AA <45 degrees.

A3.3. Control Zone. The control zone (**Figures A3.1 and A3.2**) is generally defined as 2,500 to 4,500 feet behind the training aircraft's 3/9 line where range divided by 100, AA, and angle off nose are all roughly the same number, and when the maneuvering aircraft is on or near the training aircraft's turn circle. The control zone allows the maneuvering aircraft to "control" the training aircraft's actions by forcing it to keep turning for survival or immediately allow for a potential AIM-9P or gun WEZ entry. It is a position that also makes the training aircraft predictable prior to pulling lead pursuit or setting pure pursuit for weapons employment. The back of the control zone represents a "pressure" limit, forcing the training aircraft to turn to stay alive. The front of the control zone represents a "reaction" limit, generally forcing the maneuvering aircraft to reposition if closure or AA increases by even a small amount. In order to transition to a stable WEZ, it is critical to maintain energy while in the control zone. As a rule of thumb, the "heart" of the control zone is between 3,000 and 3,500 feet with an aspect of 30 to 40 degrees from the training aircraft. From this position, the maneuvering aircraft can transition to an AIM9P or 20MM gun WEZ with enough time to employ valid ordnance and then reposition in a timely manner (if required).

Figure A3.1. The Control Zone.

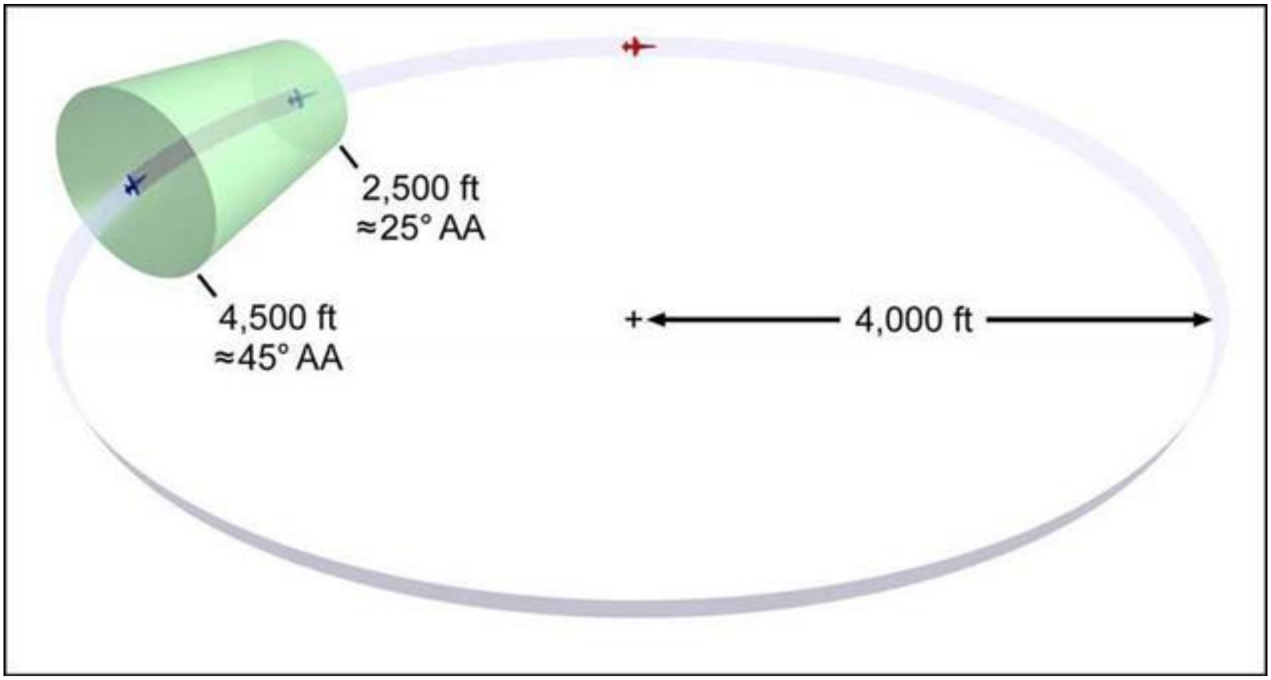
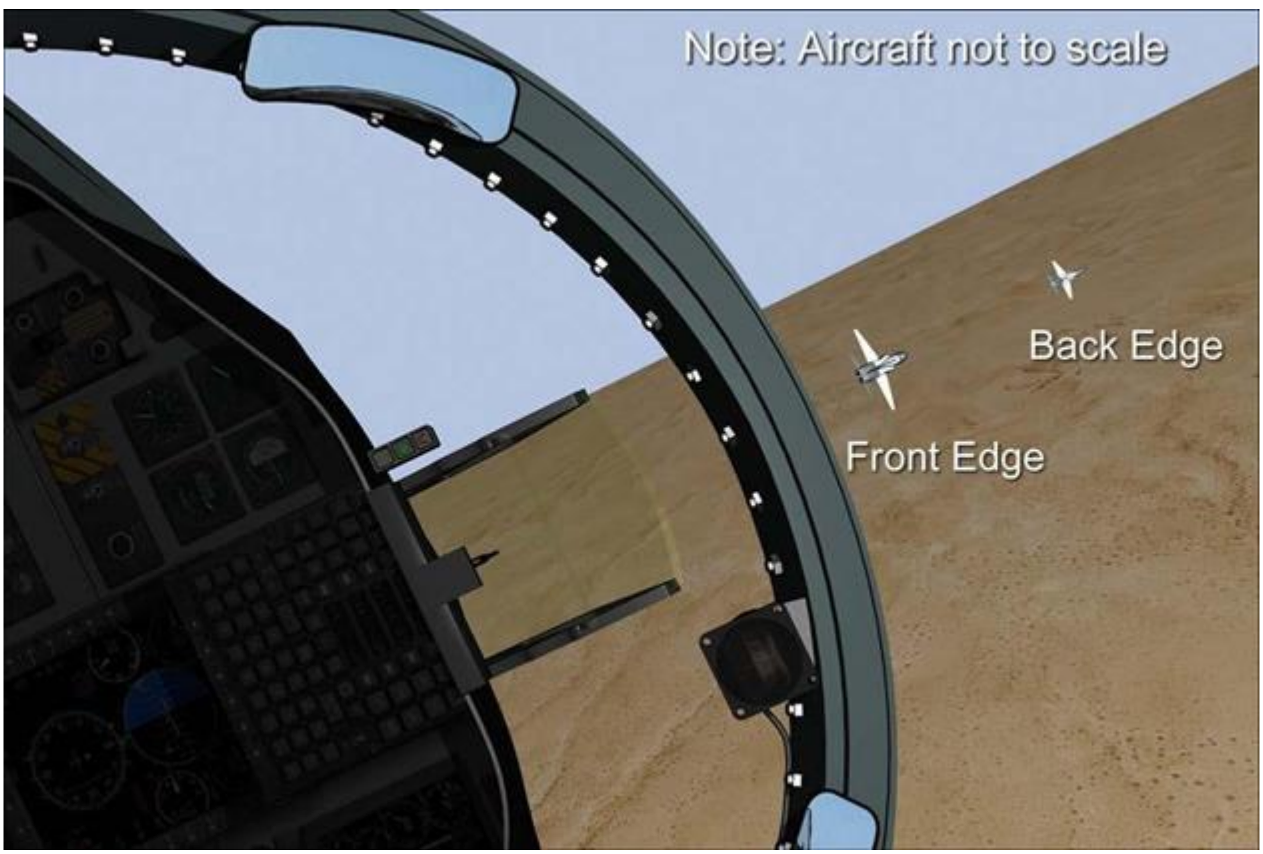


Figure A3.2. Control Zone Canopy Bow References.



A3.4. Shot Validity. Valid gun and missile shots must be taken from within the WEZ for the weapon and must meet either of the criteria in **paragraph A3.4.1** or **paragraph A3.4.2** for sighting and time of flight (TOF). A snap is any valid gunshot less than 15 frames. A track is any combination of valid guns shots equaling 15 frames. The T-38C VDTS records 30 frames per second.

A3.4.1. Gunshots Using the Enhanced Envelope Gunsight (EEGS) Funnel. Use the firing evaluation display system (FEDS) developed at trigger pull to determine TOF and valid frames. Any part of the center of the FEDS touching the target at the correct range (matching the width of the FEDS dots) counts as a valid frame.

A3.4.2. Gunshots Using the Lead Computing Optical Sight (LCOS). Use one frame per 100 feet (range to training aircraft) to assess TOF. A frame is assessed as valid if the two mil pipper is touching the target inside 2,500 feet after the TOF requirement is satisfied.

A3.4.3. AIM-9P Shot Validity. A valid uncage consists of the target's heat source in the 17.5 mil seeker reference circle (caged FOV) during the transition to the 30-mil (uncaged) circle. Once uncaged, the target must remain in the HUD FOV until pickle. The sun in the HUD FOV at pickle will invalidate the shot.

A3.5. Guns-Tracking Exercise:

A3.5.1. DLO. The DLO is a valid guns track. This exercise can be flown in conjunction with the heat-to-guns exercise.

A3.5.2. Guns-Tracking Exercise Setup and Special Instructions (SPINS) (**Figure A3.3**):

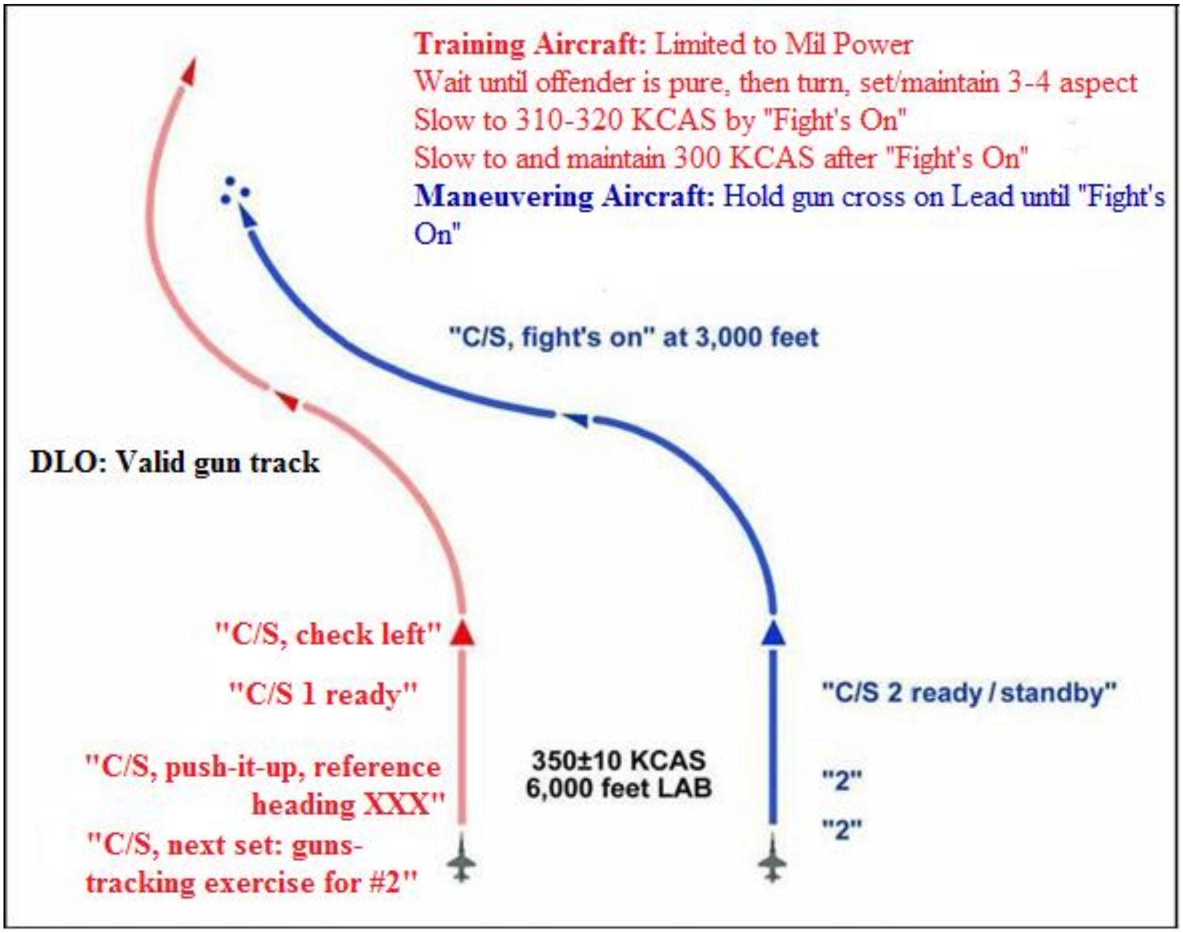
A3.5.2.1. Altitude block—15,000 to 17,000 feet MSL (or as briefed). Aircraft will be co-altitude (+500 feet) before beginning the exercise.

A3.5.2.2. Airspeed—350 (+10) KCAS.

A3.5.2.3. Range—6,000 feet line abreast.

A3.5.2.4. Minimum Range. ***The minimum range between aircraft at all times is 1,000 feet.***

Figure A3.3. Guns-Tracking Exercise.



A3.5.3. Avionics. When the flight lead initiates the "next exercise" call, ensure air-to-air master mode is selected, and cycle the master arm and CMD switches as required to reset the weapons.

A3.5.4. Communication. When both aircraft are ready, lead will initiate a check 45 left/right away from the maneuvering aircraft. When the maneuvering aircraft reaches 3,000 feet with a 30- to 40degree aspect, the maneuvering aircraft will make a "C/S, fight's on" call. Refer to unit standards for specific communications guidance.

A3.5.5. Training Aircraft. After the check left/right is initiated, the training aircraft will select MIL power and initiate a level turn away from the maneuvering aircraft while maintaining 350 KCAS. After 45 degrees of turn, roll out and regain the visual of the maneuvering aircraft. Once the maneuvering aircraft reaches pure pursuit, reverse the direction of turn and use G as required to ensure a 30- to 40degree AA is set for the maneuvering aircraft. This picture equates to roughly one fist width above the canopy bow (**Figure A3.4** [**Note:** Bandit not to scale]). At the "fight's on" call, pull 4 Gs with MIL power in a level turn, allowing airspeed to slow toward 300 KCAS. Continue flying a level to slightly descending constant airspeed turn at MIL power (usually no slower than 300 KCAS).

Figure A3.4. Setting the "Fight's On" AA.

A3.5.6. Maneuvering Aircraft. After the check left/right is initiated, select MIL power and make a level turn toward the training aircraft while maintaining 350 KCAS. Pull the nose of the aircraft until just prior to achieving pure pursuit then reverse direction to maintain pure pursuit. At a range of 3,000 feet and a 30- to 40-degree AA, make the "fight's on" call. The maneuvering aircraft is in the heart of the control zone.

A3.5.6.1. Transitioning from the Control Zone to the Gun WEZ. Align POM with the training aircraft and pull lead to place the training aircraft inside of the gunsight. When transitioning from the control zone to a WEZ, the maneuvering aircraft is building geometric closure as it cuts to the inside of the training aircraft's turn circle. Be aware that the training aircraft will be cooperative and will not maneuver to present additional closure and POM problems for the maneuvering aircraft. Expect initially to maintain the "fight's on" power setting until established in the heart of the WEZ, followed by power modulation to sustain the WEZ. To control closure, reduce power as required once lead is assured. Generally, "lead is assured" if pulling the training aircraft into the HUD creates little to no buffet. With a good airspeed advantage, power can be pulled to idle as early as when the training aircraft reaches the canopy bow. The faster the training aircraft reaches the HUD, the earlier the power needs to be pulled back. Contrarily, if barely able to get the training aircraft to the HUD due to moderate buffet, lead may not be attained or maintained without an increased power setting, to include the use of afterburner.

A3.5.6.2. In Range. While maneuvering from the control zone to the WEZ, expect the training aircraft to be within range by the time lead and POM are solved; however, use mil sizing to ensure employment inside MAX range (2,500 feet).

A3.5.6.2.1. Funnel. The training aircraft is in range when the wings fill the width of the funnel at the middle pipper (2,500 feet). The minimum range of 1,000 feet is achieved with the training aircraft's wings reaching the edge of the funnel at the top dot.

A3.5.6.2.2. LCOS. The training aircraft is in range when the wings fill the width of the inner circle of the LCOS sight. The minimum range of 1,000 feet is achieved when the training aircraft's wings are at the edges of the outer circle of the LCOS sight.

A3.5.6.3. POM. The funnel and the gun-sight depression line connecting the LCOS pipper to the gun cross show the maneuvering aircraft's POM, making the POM solution intuitive. Nonetheless, pulling the gun cross in front of the training aircraft to its predicted flightpath before attempting to align the POM will mitigate over controlling inputs and aid in stabilizing the gunshot.

A3.5.6.4. Lead. With the funnel, a good technique of ensuring lead prior to weapons employment is to pull until the target aircraft's wings are just slightly overlapping the funnel at the 2,500-foot reference, then gently relax backstick pressure allowing the aircraft's wingspan to match the outside of the funnel edges. With the LCOS, pull lead to position the pipper on the training aircraft's nose, then gently relax backstick pressure allowing the aircraft to fly through the pipper.

A3.5.6.5. Gun Employment. Prior to opening fire, ensure feet are on the floor or exerting symmetric pressure on the rudder pedals. Unintentional yaw inputs will case POM errors. Using fine muscle movements, stabilize the aiming reference on the center of the target aircraft. Adjust power as required based on closure, aircraft buffet cues, and LOS rate. Small adjustments in back-stick pressure and lateral stick displacement will be required to refine aiming based on continuously changing range and POM. Adjust for POM error using lateral stick pressure by attempting to adjust for one-half the distance of FEDS or LCOS pipper displacement. A controlled gunshot could be considered a 2- to 3-second lethal burst. This time may be shortened based on range, closure, and significant aiming errors. Consider it a waste of bullets to attempt a gunshot for longer than 3 seconds. Marksmanship is critical. At 60 rounds per second, 450 rounds of simulated bullets will be depleted in approximately 7 seconds. Expect approximately 90 to 120 degrees of turn to obtain a valid track prior to terminating the exercise. Be aware of the potential to fly through the target aircraft's jet wash.

A3.6. Heat-to-Guns Exercise:

A3.6.1. DLOs. The DLOs are achieved by employing a valid Fox 2, executing an effective turn circle entry, and achieving a valid guns track. A common termination point for the exercise occurs at the completion of a valid gun attempt or if the student fails to achieve a valid gun solution on the initial attempt.

A3.6.2. Heat-to-Guns Exercise Setup and Special Instructions (SPINS) (Reference **Figure A3.5**):

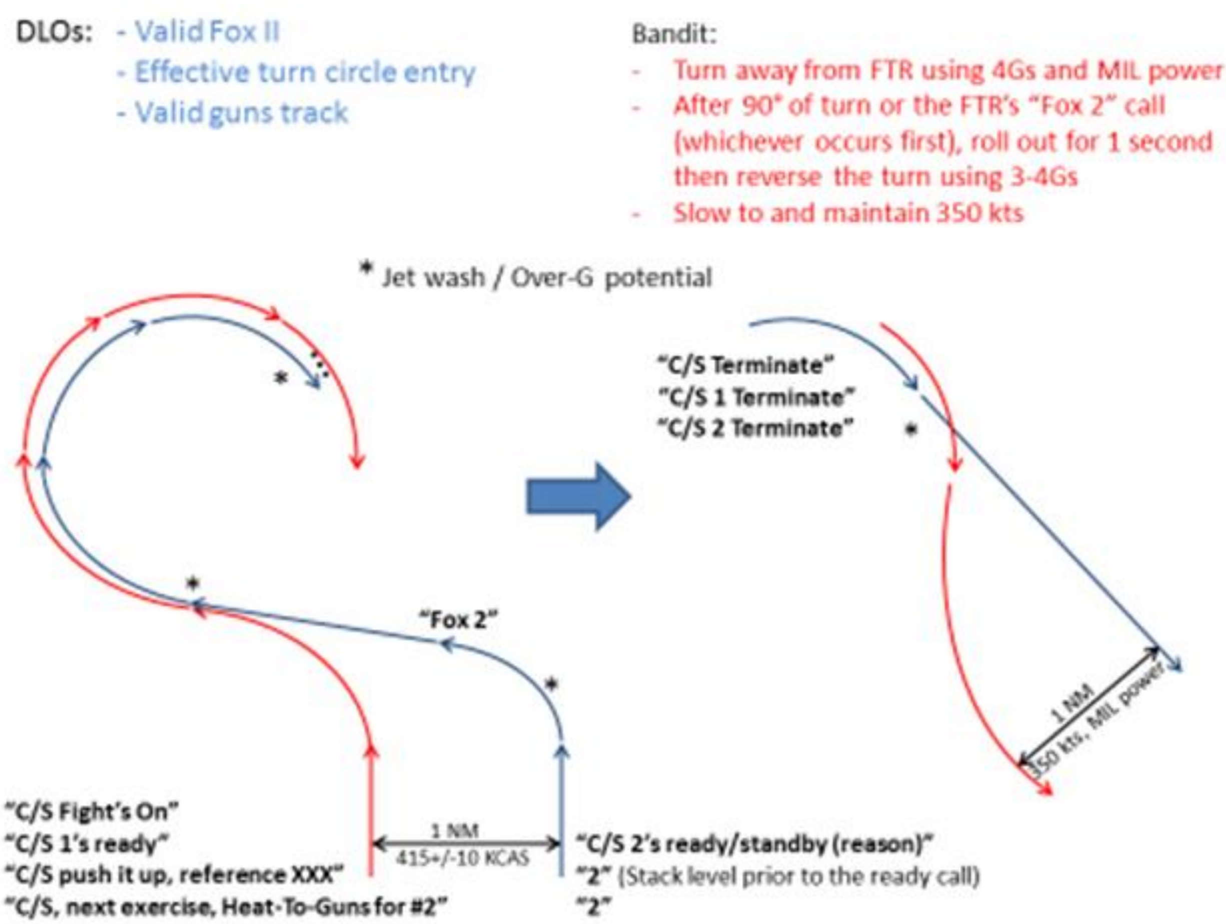
A3.6.2.1. Altitude block—15,000 to 17,000 feet MSL (or as briefed). Aircraft will be co-altitude (+500 feet) before beginning the exercise.

A3.6.2.2. Airspeed—415 +10.

A3.6.2.3. Range—6,000 feet line abreast.

A3.6.2.4. Minimum Range. ***The minimum range between aircraft at all times is 1,000 feet.***

Figure A3.5. Heat-to-Guns Exercise.



A3.6.3. Avionics. Ensure air-to-air master mode is selected, and cycle the master arm and CMD switches as required to reset weapons.

A3.6.4. Communication. Refer to specific communications guidance in unit standards. See Figure A3.5 for a communications example. Lead will initiate an ops check then inform the wingman of the next setup (e.g., "C/S, next exercise will be a heat-to-guns for #2."). Two will acknowledge with position number. While in tactical formation, lead will then give a "C/S, push-it-up" call, with a reference heading if required. After reaching briefed starting parameters, lead will initiate a “ready” call. When both aircraft are ready, lead will call “C/S, fight’s on.”

A3.6.5. Training Aircraft. At the “fight’s on” call, the training aircraft will initiate a MIL power, 4-G level turn away from the maneuvering aircraft. At 90 degrees of turn, roll out and modulate power not to exceed 410 KCAS. As soon as a ”FOX 2” is called by the maneuvering aircraft, the training aircraft will either immediately reverse the turn (if still checking away) or begin a turn in either direction and maintain 3 to 4 Gs while slowing to 350 KCAS and MIL power. Continue flying a level to slightly descending constant airspeed turn at MIL power.

A3.6.6. Maneuvering Aircraft. At the “fight’s on” call, start the AGSM, select MAX afterburner, set the LV on the training aircraft, and perform best break turn. The best break turn is accomplished by pulling the stick to a known 4-5G position, then blending in backstick pressure to the single-rate beeper. As the training aircraft enters the HUD FOV, simultaneously relax the G, reduce the throttles to maintain 410 +10 KCAS, and attempt a valid AIM-9 shot. Call “FOX 2,” and prepare to enter the training aircraft’s turn circle

A3.6.6.1. AIM-9 Employment. When pulling the training aircraft into the HUD, consider a slight relax of G as required to slow the training aircraft’s LOS rate to the missile seeker FOV. With the target’s heat source in the missile FOV, uncage the missile. Attempting to hold or freeze the target aircraft in the center of the seeker FOV for too long can result in a significant closure problem and decrease the time available to prepare for follow-on maneuvers. After employing the AIM-9, call “Vega 2, Fox 2,” roll out, and begin a slight climb (normally FPM 3 to 5 degrees above the horizon) to avoid the training aircraft’s jet wash. Modulate power to accelerate back to or maintain 410 KCAS while approaching the target aircraft’s point of return.

A3.6.6.2. Turn Circle (TC) Entry Recognition Cues. Recognizing the proper TC entry cues proves vital to successfully entering the control zone. The maneuvering aircraft is on the TC when ***an increase in the aft LOS rate*** of the training aircraft occurs. Another recognizable cue happens when the rotational motion of the training aircraft turns into aft translational motion (AA stops increasing). Due to the low turn rates of the T-38, this increase in LOS rate is relatively subtle. The most common visual crutch is to begin maneuvering once the training aircraft reaches a point just outside the canopy bow.

A3.6.6.3. Assessing a WEZ. At the turn circle entry, begin AGSM, select G and power as appropriate (usually MIL), set the LV near the training aircraft, and start a light to moderate buffet pull. Be aware of the potential to fly through the training aircraft’s jet wash. As the training aircraft approaches the canopy bow, assess range, aspect, and closure. The area within one to two fists of the canopy bow is referred to as the “assessment window.” Commonly briefed cues to search for during this assessment include 3,000 feet of range, 30 to 45 degrees of aspect, and steady, controllable closure (referred to sometimes as the “rule of threes” or “attack cues”). Details on the training aircraft’s jet provide the most accurate method to determine range. At 3,000 feet, the training aircraft has a clearly visible canopy and canopy bows, distinct lines where the wings and tail meet the fuselage, and clear lines where the colors on the paint scheme change. To determine 30 to 45 degrees of aspect, refer to the wingspan versus length relationship. To determine acceptable closure, the training aircraft’s jet should slowly grow larger. If the jet is rapidly growing larger or smaller, improper closure exists. During the heat-to-guns exercise, range and aspect should look appropriate for transition to the gun WEZ. If all three cues from the training aircraft exist at the canopy bow assessment window, continue to pull the training aircraft into the HUD and employ ordnance. If one or more of the cues are not met, execute an ease reposition as described in **paragraph A3.6.6.4**. An ease reposition will help to solve range and aspect by realigning turn circles.

A3.6.6.4. Ease Reposition. If the range, aspect, and closure cues are not met at the canopy bow assessment window, execute an ease reposition to drive the range and aspect lower. An ease reposition drives the maneuvering aircraft back toward the training aircraft's turn circle, reducing closure and aspect in the process. Execute an ease reposition by relaxing backstick pressure to reduce G. Modulate power as required to maintain the desired rate fight airspeed. When reducing G, the fighter will see aft LOS from the training aircraft (away from the canopy bow) as well as a reduction in aspect. Expect LOS to be immediate, although the amount of time required during the ease will vary based on the range, angles, and closure presented by the training aircraft at the time of the ease. Select MAX afterburner; reset the LV for best rate; and blend the G back in. Maintain the best rate until the training aircraft again enters the canopy bow assessment window. Assess and either execute another ease reposition or pull G as required to enter the AIM-9/gun WEZ.

A3.6.6.5. Gun Employment. Once committed to transitioning from the control zone to the gun WEZ, pull lead and establish POM while controlling closure. For mechanics, refer to gun employment in **paragraph A3.5.6.5**. While employing the gun, the maneuvering aircraft may need to reposition. The reposition is a calculated bid to lag, using the vertical and induced drag to solve range, aspect, and closure problems. The maneuvering aircraft should reposition for either frag created from the valid gun kill or range and closure problems created during the gun attempt. Always reposition the aircraft before entering the 1,000-foot bubble around the training aircraft.

A3.6.6.6. Reposition Mechanics. Rotate the LV away from the training aircraft; power placement, degree of LV change, G, and AOA used will depend on the severity of the BFM problem the maneuvering aircraft is trying to solve. If unsure, a good default is to use idle, set the LV 60 to 90 degrees above the training aircraft (typically, perpendicular to the horizon), and use a smooth but deliberate pull to the moderate buffet. Once arriving on or near the training aircraft's turn circle, begin pull back towards the training aircraft to reduce HCA and begin the reassessment. Throttle position will depend on LOS and range cues from the training aircraft. Recommit as required for an AIM-9 opportunity on the way back to the gun WEZ. Be aware of position relative to the training floor during the recommit.